

RESTORATION FEASIBILITY STUDY

FINAL REPORT



COLORADO LAGOON

prepared for :  City of Long Beach

prepared by :  Moffatt & Nichol

February 4, 2005

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Prepared for:

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EXECUTIVE SUMMARY

This Colorado Lagoon Restoration Feasibility Study utilizes results of previous project tasks and public input to rank restoration alternatives for implementation. A list of the next steps is specified for the City to follow to turn their vision into reality. The lagoon is impaired for sediment quality, and is also degraded in terms of habitat, water quality and the recreational experience. A team of State and City staff, consultants, Technical Advisory Committee members and the public have worked together to assess existing problems and devise solutions. This report carries analysis to the point of prioritizing and specifying future actions.

Alternatives were removed from consideration for various reasons, others were optimized, and the balance were retained for future implementation. The net result is that a list of alternatives is recommended to move forward for implementation in a particular order. The alternatives are categorized into those to accomplish remediation and those to accomplish restoration, and they are to be implemented with remediation to occur first to create a suitable environment for restoration.

Alternatives can be implemented individually to enact solutions and be complementary to one another, or they can be implemented collectively as part of a Master Plan. Alternatives are prioritized in the case that they cannot be implemented in total. It is recommended that Alternative 1a (culvert cleaning and removal of impedances) be implemented immediately and the results monitored in order to provide guidance on the need for further remediation.

This project addresses the issues that were identified as significant for consideration at the outset of the study, and identifies additional issues to resolve. These issues will be addressed as part of the next phase of project implementation. The tasks for addressing each of these issues are included in the separate “Scope of Work for Next Phase of Restoration Plan” deliverable.

The recommended course of action for restoration in the near-term includes:

1. Perform data gathering to fill data gaps.
2. Apply for funding to implement and monitor the alternatives.
3. Design and implement a pre-restoration monitoring plan.
4. Perform environmental review and permitting of the preferred alternatives.
5. Perform final engineering for construction of the alternatives.
6. Implement Alternative 1a coupled with monitoring of tides, turbidity, and bacteria and dissolved oxygen levels. If desired improvements to these variables does not occur, pursue implementation of Alternative 1c (Open Channel With Culvert).
7. Based on results of data analyses in Step 1 above, implement Alternative 2 (West Arm Sediment Removal) and possibly Alternative 3 (Central Sediment Removal).
8. Implement all other preferred remediation and restoration alternatives as funding becomes available, including development of a sand management plan as part of Alternative 17b.

1.0 INTRODUCTION

Colorado Lagoon is a relatively small tidal lagoon in the City of Long Beach. The lagoon is connected to Alamitos Bay and the Pacific Ocean through a tidal culvert to Marine Stadium. It serves three main functions of hosting sensitive habitat, providing public recreation, and retaining and conveying storm floods. The site is degraded in many respects due to being overburdened by these competing uses. The goal of the Colorado Lagoon Restoration Feasibility Study is to evaluate and recommend feasible alternatives to restore the marine ecosystem and support safe recreation while improving water and sediment quality and managing storm water. Figure 1 provides a vicinity map and Figure 2 shows an aerial photograph of the project site.

1.1 PURPOSE OF THE STUDY

The purpose of this report is to:

- Document information gathered as part of previous tasks
- Update evaluation of restoration alternatives and
- Present a recommended course of action for implementation.

The total set of alternatives was developed and assessed as part of two previous deliverables for this project. The *Development and Evaluation of Restoration Alternatives* report (Moffatt & Nichol or M&N, 2004d) assessed each alternative for hydrologic regime, flood control impacts, environmental benefits and impacts, habitat changes, maintenance requirements, and estimated costs. The *List of Preferred Alternatives* deliverable (M&N, 2004e) recommended a subset of the total alternatives list based on feedback from the Technical Advisory Committee (TAC) and public stakeholders at a public meeting conducted on October 28, 2004, and results of the alternatives evaluation. Following submittal of these two deliverables, comments were received from TAC members and from the Friends of Colorado Lagoon (FOCL) stakeholder group. This report addresses these comments, presents revisions to the previous alternatives evaluation, provides a basis for understanding the various alternatives considered, and presents a preferred set of alternatives. This report also compares and ranks each of the alternatives for achieving the project objectives and for project costs. Project objectives were established as part of the initial work program and expanded upon at the first TAC/public meeting (M&N, 2004a). They are listed below for reference.

Objectives:

- Redirect, reduce, or treat storm and dry weather runoff to minimize contamination of water and sediment in Colorado Lagoon.
- Identify sources of pollutants and recommend controls within the watershed.
- Evaluate the need to remove contaminated sediments.
- Restore and maintain estuarine habitat.
- Improve Colorado Lagoon's circulation and the tidal connection with Marine Stadium and Alamitos Bay.
- Balance flood control, recreation, and pollution abatement at Colorado Lagoon.

- Enhance public enjoyment of the lagoon.
- Create a sediment management plan for imported beach fill sand.
- Address next phase implementation funding.

The alternatives have been identified as individual components to allow individual components to be phased and prioritized for incremental funding. Each alternative has been assigned a number. Implementing all of the components would define the maximum project alternative, or the “Master Plan.”

1.2 *DEFINITION OF PROJECT SITE ZONES*

Colorado Lagoon is unique in that it supports recreational activities such as swimming and picnicking, as well as providing a natural estuarine habitat and serving as a part of the stormwater management system. In order to maximize the potential for success of the various uses, the lagoon is divided into specific geographic zones each with an intended purpose. For instance, the grassy area and beach along the south side would continue to be used for recreation and would be designated as “Zone 1 – Recreation Area.” The north arm would provide an estuarine habitat area while still allowing for public access and would be designated as “Zone 2 – Natural Habitat.” The western arm would provide an isolated habitat area, off-limits to public access, and would be designated as “Zone 3 – Ecological Preserve.” By creating the specific zones, those activities compatible with the intended uses for that zone can be prescribed (FOCL, 2004). All zones will continue to serve the stormwater management function, although the amount and quality of discharge from the storm drains will be improved upon implementation of the various alternatives identified in this study.

2.0 SCOPE OF WORK

As specified in the work program document, the entire scope of work for this project includes:

- Task 1 – Establish Project Goals and Objectives
- Task 2 – Water Quality Assessment
- Task 3 – Sediment Quality Assessment and Options for Sediment Disposal
- Task 4 – Characterize Hydrologic and Hydraulic Conditions
- Task 5 - Characterize Tributary Watershed Activities Impacting the Lagoon
- Task 6 – Water Quantity Assessment
- Task 7 – Habitat Assessment
- Task 8 – Develop Opportunities and Constraints to Habitat Restoration
- Task 9 – Develop and Evaluate Restoration Alternatives
- Task 10 – Finalize Restoration Alternatives
- Task 11 – Prepare Conceptual Restoration Plan (Final Report)
- Task 12 – Prepare Scope of Work for Next Phase of Restoration Planning
- Task 13 – Public Involvement
- Task 14 – Reporting

This report is the deliverable for Task 11. The deliverable for Task 12 is to be submitted concurrently. All other tasks have been completed. This Task 11 report was prepared utilizing and building upon results of previous tasks and public input to identify the alternatives to be implemented and their order of sequence.

3.0 BASIS OF DESIGN FOR ALTERNATIVES

Formulation of alternatives is limited by existing conditions as represented by data analyzed in previous tasks, and other factors described in the Alternatives Evaluation Report (M&N, 2004d). Certain major elements affect the development of alternatives including the Termino Avenue Drain Project (TADP) and the adjacent golf course operation. Existing data, the TADP, and golf course are revisited below as they affect the formulation of alternatives.

3.1 SUMMARY OF EXISTING DATA

Previous tasks involved field studies and evaluation of available existing data. The results of these tasks were presented in previous reports. Table 1 summarizes these reports and their key findings as they bear on alternatives formulation and ranking.

3.2 OTHER FACTORS AFFECTING RESTORATION

Several other factors exist that may bear on the success of the restoration. The alternatives were designed to accomplish restoration under the limitations posed by regulations, related projects and adjacent land use described below. Coordination with the following efforts will further enhance the potential for success of this project.

3.2.1 Beneficial Use Designation of the Basin Plan

The Regional Water Quality Control Board Region 4 Basin Plan (California RWQCB, 1994) classifies the Colorado Lagoon's existing beneficial uses as:

- REC 1 – Water Contact Recreation – uses of water for recreational activities including body contact with the water, where ingestion is reasonably possible. These uses include swimming, wading, scuba diving, and fishing. A Basin Plan Amendment (RWQCB 2001) defines water quality levels for REC-1 uses. These levels reflect the State AB-411 single sample standards and the 30-day geometric mean standards, to which the Colorado Lagoon is currently being tested.
- REC 2 – Non-contact Water Recreation – uses of water for recreational activities involving proximity to water. These uses picnicking, sunbathing, beachcombing and sightseeing.
- COMM – Commercial and Sport Fishing – uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption.
- WILD – Wildlife Habitat – uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife, or wildlife water and food sources.

- SHELL – Shellfish Harvesting – uses of the water that supports habitats suitable for the collection of filter-feeding shellfish (e.g. clams and mussels) for human consumption.

It lists a potential beneficial use as:

- WARM – Warm Freshwater Habitat – uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.

3.2.2 The Termino Avenue Drain Project

The County of Los Angeles Termino Avenue Drain Project (TADP) consists of modifying the downstream end of the storm drainage system from one of the watershed sub-basins draining into Colorado Lagoon. The project involves increasing the capacity of the storm drainage infrastructure sufficiently to promote adequate drainage from the upstream sub-basin. The predicted result of the project would be increased storm flow peak discharge during storms. The project would also result in reduced low flows during the dry season as the nuisance effluent would be diverted to the sanitary sewer, or otherwise routed away from the lagoon.

There are three scenarios associated with the TADP: 1) no project, 2) implementation of the TADP with a redesigned storm drain outlet to the Colorado Lagoon western arm with low flows being diverted to Marine Stadium and the sanitary sewer treatment plant, resulting in increased storm peak flows and decreased dry weather flows into the lagoon; and 3) implementation of the TADP with the outlet relocated to Marine Stadium, resulting in decreased storm and dry weather flows into the lagoon.

Basin hydrographs were developed and hydraulic analyses were performed for the first two scenarios, which represent the worst cases at the lagoon from a hydraulics standpoint. Implementation of the TADP also affects the proposed changes to the entire storm drain system into the Colorado Lagoon. The TADP will utilize some of the sanitary sewer treatment plant capacity, thus limiting the amount of low flows that can be diverted from the remaining Colorado Lagoon drains. The other consideration is that the TADP provides a potential opportunity to reroute the storm drain that outfalls into the swimming area of the lagoon. Figure 3 shows the proposed storm drain infrastructure changes assuming that the TADP is not implemented. Figures 4 and 5 show the proposed changes assuming that the TADP is implemented, for each of the two TADP outlet location alternatives.

The project team determined at the outset of this study that the most conservative analyses of impacts to habitat, recreation and flood control (greatest potential impact) would be to assume the TADP discharges into Colorado Lagoon (leading to poorer water quality, sediment quality, habitat and recreation at the lagoon). If the project still provides significant benefits and limited impacts even under the scenario of the TADP issuing to Colorado Lagoon, then it can be concluded that the project will result in even greater benefits with fewer impacts under the scenario of TADP issuing to Marine Stadium. Therefore, the conclusions presented herein can also be applied to the scenario of the TADP outlet directed to Marine Stadium. The Colorado Lagoon restoration

project will result in greater benefits to water quality, sediment quality, habitat and recreation at the lagoon than predicted in these studies if the TADP is routed into Marine Stadium. Routing the outlet to Marine Stadium will reduce stormflows and associated pollutants contributed to the Colorado Lagoon ecosystem. Less bacteria, fewer nutrients, reduced volumes of sediments, trash and debris will be deposited in the lagoon during storms, thereby preserving higher quality conditions of recreation, water and sediment quality, and biota.

3.2.3 The “Little Rec” Golf Course

The golf course located adjacent to the lagoon is commonly referred as “Little Rec” because it is the smaller of the two City public recreational golf courses in the vicinity. The course is a viable 9-hole system abutting the north shore and western lagoon arm. The lagoon is impacted by the proximity of the course as evidenced by errant balls deposited in the mudflat along the western arm north end, possibly compromised water quality (affected by irrigation runoff from the course in the dry season), and the existence of invasive non-native landscaping at the course perimeter that degrades habitat quality. In addition, the City of Long Beach Local Coastal Program (City of LB, 1980) stated that the land distribution between the golf course and the lagoon should be addressed to preserve lagoon habitat.

Alternatives that affect the golf course were recommended as part of this study. These actions, if implemented in isolation from other actions, may affect the viability of the course. This effect is not able to be defined as part of this study because it is beyond the scope of work. According to course representatives and City Staff, elements of the golf course interrelate as a system. Therefore, redesign of the whole southern portion of the course will be required to implement all alternatives. Recommending other changes throughout the entire southern course are also beyond the scope of this study and are therefore not included herein.

According to the TAC, other improvements to the golf course operation should be considered to protect lagoon resources including reducing watering needs and elimination of pesticide and herbicide use given their proximity to a sensitive biological area. The course operator could also consider eliminating the blanket of turf and adopt a more eco-friendly course where islands of turf are surrounded by coastal sage scrub, native meadows and grasslands that not only beautify the course but also provide additional complexity to the course. The Audubon Society has a program where they will work with the course operator and assist to develop plans for an Audubon-friendly golf course (see <http://ca.audubon.org> for information, or see <http://www.blackberrypatchgolf.com/course.asp> for an example of Audubon-friendly golf course). Finally, the TAC suggested installation of soil moisture meters to provide sufficient data to enable the course operation to reduce watering and resultant runoff.

Table 1. Summary of Information Gathered for This Study

Report	Key Findings	Recommendations	Data Gaps
<i>Water Quality Assessment Report, Kinnetic Laboratories, Inc., August 2004.</i>	<p>Bacteria sampling from December 2000 to August 2004 showed several AB411 exceedances mostly for total coliform and E.coli (fecal coliform) / total coliform ratios and to a lesser extent for exceedances for enterococcus and E.coli (fecal coliform) during both wet and dry seasons.</p> <p>August 2004 sampling showed storm drain bacteria concentrations being an order of magnitude higher than the receiving waters, and that early morning sampling concentrations are an order of magnitude higher than at noon-time.</p> <p>Water sampling for chemicals during January 2001 to July 2004 showed overall concentrations of most analytes were extremely low. All chlorinated pesticides, PCBs, and organophosphate pesticides were below detection limits and none of the trace metals exceeded the California Toxics Rule criteria.</p> <p>July 2004 survey showed high nutrient levels from the eastern storm drain (only drain sampled).</p> <p>Trash appears to be mostly from recreational use at the lagoon.</p>	<p>Implement upstream watershed BMPs.</p> <p>Reduce number of storm drain outlets into lagoon</p> <p>Implement storm drain dry weather diversion to the County sewage treatment plant</p> <p>Install bio-swales and berms.</p> <p>Install street catch basin filters.</p> <p>Implement trash management protocols.</p> <p>Implement bird management protocols.</p> <p>Improve the culvert connection to increase flushing.</p>	Specific source of pollutants
<i>Sediment Testing and Material Disposal Report, Kinnetic Laboratories, Inc. and Moffatt & Nichol, July 2004.</i>	<p>Western arm contained the highest contaminant levels – included lead which exceeded the Title 22 hazardous level, but not Federal limits. Also found DDT, chlordane, and dieldrin which exceeded the NOAA ERM* threshold and PCBs, PAHs, cadmium, copper, mercury, silver and zinc which exceeded the NOAA ERL* guideline. Sampling was generally consistent with the State 303(d) impaired water body contaminants list.</p> <p>Culvert area contained lead, mercury, silver, DDT and chlordane which exceeded the ERL* guideline.</p> <p>Northern arm contained ERL exceedances for only DDT.</p>	<p>Remove sediment in western arm and dispose at offsite landfill or Port opportunistic fill site.</p> <p>Contamination levels in culvert area do not require removal, but material could be removed and used on-site if needed as part of the lagoon's future restoration efforts.</p>	Specific source of pollutants.

Report	Key Findings	Recommendations	Data Gaps
<i>Watershed Impacts Report, HDR/CGvL, July 2004.</i>	<p>The lagoon's watershed is 66% residential, 19% open space, 11% commercial and 4% institutional.</p> <p>Potential sources of pollutants within the watershed are identified as construction sites, commercial parking area washing, golf course and residential lawn overwatering and fertilizer use, and pet waste.</p> <p>Trash in the lagoon is brought in via storm drains.</p>	<p>Some need for further BMP development and/or enforcement.</p> <p>Install street catch basin filters.</p>	Profiling of the watershed sub-basins water quality and loading, including sampling during storms.
<i>Tidal and Flood Hydraulics Study, Moffatt & Nichol, July 2004c.</i>	<p>Finite element hydraulic model of Colorado Lagoon showed:</p> <ul style="list-style-type: none"> ▪ The lagoon's low tides are cut off by ~2 feet as compared to the ocean tide and Marine Stadium and the tidal range is 4.5 feet; tidal residence times are at least one to two weeks longer than for Marine Stadium. ▪ For existing conditions, a 50-year storm event produced peak water levels of +5.7 to +5.9 feet NGVD29, higher than the lagoon area near Colorado and Eliot Streets indicating flooding of adjacent properties would occur. 	<p>Clean culvert and/or install open channel to improve tidal exchange.</p> <p>Keep culvert tide gate open at all times.</p> <p>Install flood protection dike along corner of Colorado and Eliot Streets.</p>	Potential location of sills or other obstructions within or outside of the culvert that impede tidal flow.
<i>Water Quantity Assessment, Basin Hydrograph, Moffatt & Nichol, July 2004b.</i>	<p>The 50-year storm produced the following flows:</p> <ul style="list-style-type: none"> ▪ For existing conditions: peak flow rate into lagoon of 710 cubic feet per second (cfs) and a runoff volume of 265.2 acre-feet. ▪ With proposed Termino Avenue drain outfall into Colorado Lagoon: peak flow rate into lagoon of 971 cfs and a runoff volume of 164.4 acre-feet. 	Reduce water quantity flow into lagoon by implementation of proposed Termino Avenue drain outfall into Marine Stadium, and by use of vegetated swales.	Hydrograph for the lagoon with the Termino Avenue drain outfall <u>into Marine Stadium</u> .
<i>Special Status Species Considerations, Chambers Group, Inc., July 2004.</i>	<p>16 sensitive plant species have potential to occur at the lagoon. None of these were observed at the lagoon.</p> <p>12 sensitive wildlife (bird) species have potential to occur. None of these were observed at the lagoon.</p>	Consider measures that potentially could improve the use of the lagoon by special status species.	None.

Report	Key Findings	Recommendations	Data Gaps
<i>Habitat Assessment, Chambers Group, Inc., July 2004.</i>	<p>The lagoon supports a diverse community of estuarine fishes and invertebrates and water-related birds, although the sparseness of eelgrass and juvenile halibut suggest degraded estuarine health.</p> <p>13 species of fish, 35 taxa of invertebrates, and 4 species of clams found during habitat survey.</p> <p>Heavy layer of benthic algae and a few scattered eelgrass plants cover the lagoon bottom.</p> <p>Three plant communities found: coastal brackish marsh, iceplant series and ornamental landscaping.</p> <p>Relatively diverse benthic invertebrate community in central and northeast regions of the lagoon. Impoverished invertebrate community in western arm.</p>	<p>Increase area of intertidal zone.</p> <p>Remove invasive iceplant.</p> <p>Protect habitat from human and canine intrusion.</p> <p>Improve water quality.</p>	Habitat conditions within the culvert.
<i>Development and Evaluation of Restoration Alternatives, Moffatt & Nichol, November 2004d.</i>	<p>Several alternatives were evaluated; the costs to implement the various types of actions were:</p> <ul style="list-style-type: none"> ▪ Improving tidal flushing and flooding: \$3.5M ▪ Removing contaminated sediments: \$820,000 ▪ Reducing physical encroachment onto lagoon : \$1.28M ▪ Revegetation/Buffering: \$172,000 ▪ Treating runoff into the lagoon: \$1.4M ▪ Implementing watershed improvements: \$232,000 ▪ Enhancing public enjoyment: \$326,000 <p>Cleaning the culvert potentially improves the spring tidal range to 5.9 feet. An open channel would improve the tidal range to 7.7 feet and residence times would be reduced.</p>	<p>Implement alternatives as one comprehensive project or as a series of projects over time.</p> <p>Remove contaminated sediment in western arm.</p>	None

**ERM is Effects Range Medium and reflects the 50th percentile concentration value in the NOAA database that might be expected to cause adverse biological effects. The ERL (Effects Range Low) reflects the 10th percentile value in the database.*

4.0 PREFERRED ALTERNATIVES LIST

The letter report for Task 10 (M&N, 2004e) provided a list of preferred alternatives based on results of analyses (M&N, 2004d) and inputs from October 2004 TAC and public meetings. Certain alternatives were eliminated from consideration based on the analysis report, others are modified based on TAC and public comments, and still others remain as recommended actions from the initial screening. The final descriptions of alternatives to be carried forward is presented in Section 4.3 below, following a listing of those eliminated and descriptions of those modified.

4.1 *ALTERNATIVES ELIMINATED FROM CONSIDERATION*

The Task 10 report recommended deletion of the following seven alternative components:

- **Alternative 1b - Build open channel and discontinue use of existing culvert.** There were no substantive benefits or cost savings of this alternative versus Alternative 1c which is the alternative to build an open channel and utilize the existing culvert. The TAC and public concurred.
- **Alternative 5c – Re-grading all steep slopes and planting native vegetation.** This option involved re-grading the slopes for the eastern shore area immediately adjacent to the culvert; this would impact the current grassy park area. The public raised concern that this park gets a lot of use and they do not want it impacted.
- **Alternative 8 – Planting eelgrass in the lagoon.** Upon further consideration, the project team biologist does not recommend this action. Large eelgrass beds occur in the Marine Stadium area and eelgrass apparently is transported into Colorado Lagoon. Sparse eelgrass was observed in the lagoon by the project biologist during their underwater survey. The fact that eelgrass was observed suggests that it can migrate into the lagoon without human help. The reason beds have not become established is likely related to the poor water quality within the lagoon, especially the high turbidity. Eelgrass is dependent on high light levels. The high turbidity in Colorado Lagoon reduces the light available for eelgrass. Pollutants also reduce the viability of eelgrass in the lagoon although the sensitivity of eelgrass to various pollutants is not well known. Increased tidal exchange in the lagoon would improve water quality and probably reduce turbidity. The improved tidal exchange also would improve the transport of eelgrass seeds or sprigs into the lagoon. Therefore, once tidal exchange is improved, eelgrass likely would become established on its own. If the restoration project does not reduce turbidity and otherwise improve water quality to the extent that eelgrass transported from outside can become established, an eelgrass transplant also would be likely to fail.
- **Alternative 14a - Install full perimeter trail.** This perimeter trail would have an impact to restored habitat areas. There are other ways to provide public access (e.g. viewing platforms, telescopes). A full perimeter trail is not desired. Alternative 14b includes a limited perimeter trail that does not extend around the western arm of the lagoon so as to preclude human disturbance from this habitat area and minimize the potential hazard from errant golf balls.

- **Alternative 17c - Discontinue all sand nourishment.** Even though there is a concern about the sand nourishment impact to the lagoon, it was recognized that sand nourishment is needed in the swimming area. The alternative to modify sand nourishment practices is still on the preferred alternatives list.

The “Preferred Alternatives List” deliverable (M&N, 2004e) recommended deletion of the following two alternatives. However, FOCL as the main stakeholder requested that these be retained, although they were listed as low priorities (FOCL, 2004). As such, Alternative 16 remains included on the list of viable alternatives while Alternative 18 is deleted as discussed below.

- **Alternative 16 - Bird management.** The request was specifically to develop a plan that would address limits on non-native and fresh water bird species at the lagoon and practices to deal with those species. This alternative will be retained on the alternatives list.
- **Alternative 18 - Watershed impacts educational display.** The request was to provide signs placed along the perimeter trail to educate visitors on flora and fauna and the importance of wetlands, and to inform visitors of appropriate use of designated zones within the lagoon. These types of signs were included in Alternative 14b and thus this alternative will be revised to include the additional signs requested, and Alternative 18 will still be removed from the preferred alternatives list.

There are three other alternatives that will be removed from the preferred alternatives list, based on public and TAC comments received in December of 2004. These alternatives are:

- **Alternative 4 - Watershed Best Management Practice (BMP) recommendations.** Public comments received stated these BMPs are activities that the City of Long Beach is already doing to a certain extent to comply with the City’s NPDES permit requirement. The City is in compliance with their NPDES requirements and these BMPs would be extensions/enhancements to the City’s ongoing activities. It is recognized the BMPs recommended in that study (M&N 2004d) would be part of the City’s Stormwater Management Program and so these specific BMPs will be removed from the recommended alternatives list. However, monitoring the effectiveness of the City’s BMPs as they relate to reducing specific pollutants entering the lagoon will be included as part of a future monitoring effort. Appendix B provides a table of the recommended BMPs and the pollutant that may be reduced through implementation of that BMP. Each of the pollutants listed will be monitored as part of a proposed future effort (refer to the “Scope of Work for Next Phase of Restoration Planning” deliverable).
- **Alternative 10 - Sediment trap in the lagoon.** The negative impact and implication of containing contaminated sediments within the lagoon was deemed to outweigh the benefit of isolating the contaminated sediment to only the western arm. This was especially a concern if the western arm is to be zoned as an “ecological reserve.” It was noted that sediment traps outside of the lagoon were preferred and would be beneficial. The area outside of the lagoon to the northwest, and other off-site areas were examined as potential off-site sedimentation basins. However, due to uncertainties of which drain(s) are the main sources, and area limitations at the site

and off-site, and the complexity of design considerations no tangible areas have been identified to locate a sediment trap. Also, TAC input indicates that the trap would only serve a short-term purpose anyway, and sedimentation will be improved as much as possible through watershed BMPs, dry weather diversion, catch basin inserts, bio-swales and/or end of pipe filters such as CDS units and a redirected Termino Avenue Drain.

- **Alternative 17a – Continue existing sand nourishment practices.** The existing sand nourishment practice has served the purpose of maintaining the recreational beach, although it may also be contributing volumes of sediment to the lagoon sufficient to reduce its water storage capacity. Alternatively, the sand nourishment practice can be optimized by shortening the length of beach to be nourished to correspond to only the swimming beach area on the south shore, and sand grain size can be optimized (coarser) to remain higher on the beach with reduced sloughing. Therefore, the existing sand nourishment practice is eliminated from the list of preferred alternatives due to the potential to optimize the sand nourishment practice.

Alternatively, sediment from the beach could be managed using a cut-off wall installed within the lagoon interior to prevent beach sand from sloughing from the lagoon side slopes into the lagoon center. A cut off wall is a vertical feature that is imbedded into the lagoon underwater. It acts as a retaining wall to retain the sand beach upslope of the wall, referred to as a perched beach. The advantage of the wall would be to support the internal side slopes of the lagoon and reduce the need to import new sand to the site, thus reducing sedimentation. Sand would remain higher on the side slope, and a sharp drop off would occur on the downslope side of the wall where the lagoon bed drops off to deeper water. The disadvantage of the wall is that it is considered a hazard to recreational swimmers due to the sudden drop off. It also presents an added project cost and maintenance item. Therefore, it was concluded that the wall poses more of a liability than a benefit and the added cost is unnecessary as beach sand will likely have to be imported periodically anyway.

Also, qualitative review of lagoon bathymetry files indicates the lagoon bed has not significantly accreted (infilled with sediment) over time and therefore the wall may not be necessary. This conclusion is reinforced if sand management is modified so that imported sand is reduced in quantity, improved in quality, and simply redistributed along the beach as needed for an improved management practice.

4.2 ALTERNATIVES REVISED BASED ON TAC AND PUBLIC COMMENTS

Several of the alternatives have been revised based on TAC and FOCL comments. Revisions are summarized below.

- **Alternative 5 – Planting Native Vegetation.** The conceptual revegetation plan has been revised to include two additional locations to plant new vegetation. The first area is along the sidewalks of Colorado Street and Appian Way where a low shrubbery screen would be planted to separate the lagoon from the busy roadways, prevent trash from blowing into the lagoon, and improve the natural setting. This is in addition to the proposed shrubbery screen between the grassy lawn area and the beach area along Colorado Street and along Appian Way. The second location is also on Appian Way where an asphalt strip currently exists between the road and the

lagoon access road parking area. The asphalt would be removed and trees planted. This would create a permeable area to reduce runoff into the lagoon and help prevent erosion on the beach. It would also help separate the lagoon from the busy roadway, reduce noise, and improve the natural setting. The type and spacing of the trees would be designed to minimize obstruction of the view from the homes to the southwest. These new locations are shown in Figure 6.

- **Alternative 7d – North shore changes, including bird island.** This alternative originally included a bird island to be built on the new north shore sandy intertidal area. Concerns arose regarding human and animal disturbance associated with this location, especially since it was in the designated swimming area of the lagoon. Upon further evaluation, it is recommended that this island be relocated to the western arm. Swimming is not allowed in the western arm and human disturbance would be minimal, with the exception of golfers in the area.

The island was originally located in the central lagoon because there appeared to be greater area for placement (due to the proposed expansion of this area) and the abundance of sandy sediments to excavate and use to create the island. Also, the quantities to build the island could be lower because the shallow bottom in this location requires less grading and filling. In contrast, the western arm was narrower with less room, and it is to be deepened for sediment removal in Alternative 2, so the quantity of fill required to build the island is much greater. Also, it is technically difficult to design the island into this confined space. Finally, two large storm drains discharge into this portion of the lagoon and could potentially erode the island, or an island could impede discharge from the storm drain system. Upon further evaluation, concerns can be addressed by placing it some distance away from the drain outlets, and designing it to fit within the available footprint. The fill quantity will be greater, but it may be available from excavation of the central lagoon or elsewhere. Excavating within the central area of the lagoon was initially not recommended, but local stakeholders have indicated a desire to do so.

The idea of creating an island was to provide a water barrier from human and canine intrusion. Migrating and wintering shorebirds have large energy (food) needs and limited areas where they can forage without human disturbance. Human disturbance such as occurs on many of the beaches in the area is very harmful to shorebirds because it limits the time they can feed. It is not possible to provide foraging areas entirely free of human disturbance at Colorado Lagoon, but the intention is to improve the intertidal habitat for foraging shorebirds by reducing disturbance. Shorebirds that would be expected to benefit include least and western sandpipers, willets, dunlins, long-billed and short-billed dowitchers, marbled godwits, long-billed curlews, black-bellied plovers, killdeers, and whimbrels as well as other species.

In the unlikely event that least terns or snowy plovers do start nesting on the island, the U.S. Fish and Wildlife Service should be consulted about the appropriate measures to take to protect them, while maintaining the overall goal and objectives of the restoration project. Least terns nest successfully on two highly used beaches - Venice Beach and Huntington Beach. Therefore, if they ultimately nest at Colorado Lagoon, with extra protective measures, a nesting colony might be viable.

Establishment of a nesting colony is not, however, envisioned as the purpose of this island.

- **Alternative 12 – Storm Drain Treatments.** This alternative will be revised to address the local storm drain entering the lagoon at the swimming area on the southern shore. One option for this storm drain is to install filters for all catch basins which flow into this storm drain. The other option for this storm drain is predicated on the implementation of the proposed Termino Avenue Drain Project (TADP). This project would create an opportunity to reroute this local drain by connecting it to the TADP if it were to flow into Marine Stadium.
- **Alternative 14b – Recreational elements.** This alternative will be clarified to specify a limited perimeter trail with overlooks, additional educational signage, and rebuilding of the short pier and platform just to the west of the lifeguard station. The perimeter trail would extend around the majority of the lagoon, but would not be installed in the western arm ecological preserve area. On the northern shore, the perimeter trail would stop at the restrooms, and on the southern shore the perimeter trail would stop just to the west of the lifeguard station. The rebuilt pier would serve as a viewing platform for the western arm ecological preserve. Additional sign displays will be placed at the locations of lagoon zone transitions to inform visitors of appropriate use of the zones and to educate them about the flora and fauna and importance of natural wetlands.
- **Alternative 15 – Trash management.** This alternative originally included a debris boom to catch trash entering into the lagoon from the western arm storm drains. The debris boom will be eliminated from this alternative. Concerns were expressed by the TAC about the impact of installing this boom in the proposed restored habitat area. Instead, efforts will be focused on removing/catching the trash upstream before it can enter the lagoon.

4.3 *RESULTANT ALTERNATIVES LIST*

Preferred alternatives were presented in a previous deliverable but had yet to be prioritized. Public and TAC/CLAG comments, along with results of analyses enables them to now be prioritized to provide a feasible, effective and affordable course of action. Alternatives can be organized into two categories – remediation and restoration. All of the project goals are dependent on a clean and healthy lagoon. In order for habitat restoration to fully succeed, remediation of the lagoon must be accomplished first. The first priority thus becomes the need to address sediment and water quality. Once this has been deemed successful, resources can be focused on improving and expanding the lagoon's natural habitat and to enhance the recreational enjoyment of the lagoon. This prioritization drives implementation phasing. The preferred alternatives list, organized by the two categories of remediation and restoration is described below.

4.3.1 Remediation

The alternatives developed to accomplish remediation are listed below. The use of the word “or” indicates that either of the alternatives listed would be implemented, but not both.

- Alternative 1a. Clean culvert, repair tidal gates (optimizing their function), and remove sills / structural impedances.
- or*
- Alternative 1c. Utilize existing culvert and build open channel between the lagoon and Marine Stadium. It should be noted that a variation of this alternative would be to first clean the culvert and evaluate the improvement. If it is deemed that cleaning the culvert does not result in the desired improvement, the open channel alternative would be developed.
- Alternative 2. Remove contaminated sediment in the western arm via excavation by berming off the western end.
- Alternative 3. Remove contaminated sediment in the central lagoon via excavation and recontour the central lagoon bed if additional testing indicates this action is warranted.
- Alternative 9. Construct a flood protection dike to protect adjacent area from flooding near Eliot/Colorado Street corner.
- Alternative 11. Install treatment bio-swale outlets for the smaller concrete drains into the lagoon.
- Alternative 12. Construct low flow and first flush diversions to the sanitary sewer and install in-line trash separation devices for selected storm drains.
- Alternative 13. Eliminate golf course 7th hole long tee.
- Alternative 15. Implement/improve trash management protocols, not including a debris boom.
- Alternative 16. Implement bird management protocols.
- Alternative 17b. Modify sand nourishment practices.

4.3.2 Restoration

Alternatives involving restoration are:

- Alternative 5a. Remove exotic vegetation and plant native vegetation, with no slope recontouring, for the following areas.
- i) Western tip of west arm - remove exotic vegetation (grass) and plant native vegetation.
 - ii) Eastern shore of west arm - remove exotic vegetation (shrubby) and plant native vegetation.
 - iii) Northern tip of north arm - remove exotic vegetation (grass) and plant native vegetation. Create naturalized park area with native plantings. Public access will still be allowed and encouraged.
 - iv) Eastern shore - remove exotic vegetation (iceplant) and plant native vegetation buffer.

- v) Southern shore – plant low shrubs between concrete path and sand (near playground) and along Appian Way between parallel-parking area and sand (near lifeguard station). Also plant low shrubs between grass and sidewalk along Colorado Street adjacent to playground and picnic area. Remove asphalt and plant trees along Appian Way where current asphalt strip exists between the road and the lagoon access road parking area.

or

- Alternative 5b. Recontour side slopes and create mudflat intertidal habitat along entire eastern shore, western shore of north arm, and along western arm, and do all of 5a above.
- Alternative 6. Create/improve sandy intertidal habitat along southern shore of west arm.
- Alternative 7c/d. Move golf course fenceline, move/narrow access road and north shore parking lot (and use permeable pavement), and create upland zone along western shore of north arm, swale along northern shore golf course fenceline, bermed sandy intertidal zone along northern shore, and bird island in western arm.
- Alternative 14b. Install limited perimeter trail, viewing platforms /overlooks and telescopes, with interpretative kiosks. Rebuild pier and platform to the west of the lifeguard station.

5.0 ALTERNATIVES COMPARISONS

Ranking the alternatives for implementation requires comparisons of how effectively they meet project objectives and their costs. Information required to rank alternatives is presented in the report of *Development and Analysis of Restoration Alternatives* (Moffatt & Nichol, 2004c) and is considered in this section. That report provided detailed descriptions of each of the alternatives, including the infrastructure changes, preliminary design, and environmental benefits and impacts, and costs of each alternative. Appendix A includes an update of the analysis matrix that was provided in that report. It has been updated to respond to comments received on the report. Tables 2 and 3 summarize changes made in response to comments, some of which have already been discussed in Section 4.0.

Table 2. Alternatives Summary List – Remediation Alternatives

Alt. #	Alternative Description	Updates	Related Figure(s)
1a	Clean culvert, repair tides gates, remove impedances	Implementing this alternative will lower the maximum (spring) low tide in the lagoon and thus increase the tidal range and tidal flushing. The benefits of improved water and habitat quality from greater circulation will outweigh any possible other effects of lower water levels during spring low tides. Spring low tides may result in a smaller subtidal area over short time periods, and expanded mudflat habitat. This condition will not likely generate significant adverse aesthetics (views) or any additional odors over existing conditions. Views of mudflat areas exist along the western arm that would expand in other areas for relatively short time periods at low tides. Also, the lower mudflat will be aerated more often and lagoon waters will not experience eutrophication so odors should not be increased. A main benefit is that this project will re-create a significant amount of intertidal habitat by increasing the tidal range, changing the site from a lagoon to more of an estuary which is an under-represented habitat type in this watershed. It is important to include optimizing the operation of the tide gates for this alternative to be optimized.	Figure 7 – Tidal Elevations Curve Comparisons
1b	Open channel, discontinue use of existing culvert.	Alternative deleted.	N/A
1c	Open channel in conjunction with use of existing culvert.	See Alternative 1a discussion above. The inundation curve for the open channel alternative (Figure 10) shows a broader range of elevations and thus greater area for intertidal habitat types such as mudflat and pickleweed, in comparison to the inundation that is provided in the existing condition (Figure 9).	Figure 7 – Tidal Elevation Comparisons Figure 8 – Channel Location Figures 9 and 10 – Inundation Curves
2	Remove sediment in the western arm.	It is noted that the Colorado Lagoon is on the 303(d) list for sediment toxicity, as well as lead, chlordane, PAHs, and zinc in the sediment and chlordane, DDT, dieldrin and PCBs in tissue.	Figure 11 – Conceptual Sediment Removal Plan

Alt. #	Alternative Description	Updates	Related Figure(s)
3	Remove sediment in the central area.	The next phase Scope of Work (SOW) will propose to do additional sediment sampling in the central area swimming area to obtain a better understanding of the level of contaminants there.	Figure 11 – Conceptual Sediment Removal Plan
4	Watershed BMPs	Alternative deleted from this project’s formal alternatives list. These BMPs are ongoing City activities.	Appendix B – BMP versus Pollutant
9	Flood dike	Figure 12 shows that flooding has the potential to occur in an area adjacent to the lagoon, except for the condition with an open channel, and thus a flood dike is needed. The SOW for the next phase will propose a task to further investigate the potential that this new flood dike will cause flooding in upstream areas within the storm drain network.	Figure 12 – Flood Curves for Each of the Tidal Connection Alternatives Figure 13 – Flood Dike Location
10	Sediment trap in western arm	Alternative deleted.	N/A
11	Bioswales	Research into the effectiveness of bioswales at filtering runoff indicates that their performance is highly dependent upon runoff quantity, impervious area, swale geometry, bed material. Detailed design would occur as a future effort, but Caltrans reports indicate that bioswales are a most-effective way of removing sediment and heavy metals from stormwater (Caltrans 2004). For example, a reduction of 48% in Total Suspended Solids and 73% in Zinc was measured at locations within Caltrans Districts 7 (Los Angeles) and 11 (San Diego).	Figure 3 – Bioswale Locations for Drain Outlets
12	Storm drains treatment	Trash separation device installations and swim-area storm drain treatment added.	Figures 3, 4, and 5 – Storm Drain Treatments Without and With Implementation of TADP
13	Eliminate golf course 7 th hole long tee	None	Figure 14 – 7 th Hole Reconfiguration

Alt. #	Alternative Description	Updates	Related Figure(s)
15	Trash management protocols	Deleted debris boom.	None
16	Bird management protocols	None	None
17a	Continue existing sand nourishment practices	Alternative deleted	N/A
17b	Modify sand nourishment practices	None	Figure 15 – Sand Nourishment Locations
17c	Discontinue all sand nourishment.	Alternative deleted.	N/A

Table 3. Alternatives Summary List – Restoration Alternatives

Alt. #	Alternative Description	Updates	Related Figure(s)
5	Remove non-native plants, plant native plants	Alternative 5c deleted. New planting areas added along southern shore for alternatives 5a and 5b.	Figure 6 – Vegetation Plan
6	Sandy intertidal along southern shore of western arm	None.	None
7a	Vegetated swale and buffer zone along golf course fenceline (without moving fence).	Alternative deleted in favor of maximum alternative 7c/d.	N/A
7b	Move golf course fenceline, vegetated swale and (wider) buffer zone along fenceline	Alternative deleted in favor of maximum alternative 7c/d.	N/A
7c/d	Move golf course fenceline, move/narrow access road and north shore parking lot, create upland zone along western shore of north arm, swale along northern shore golf course fenceline, bermed sandy intertidal zone along northern shore, and island in western arm.	Island location moved to western arm. Alternative 7c (sandy berm on northern shore) combined with alternative 7d (island in western arm).	Figures 16, 17 and 18 – Island Location
8	Eelgrass Planting	Alternative deleted.	N/A
14a	Full perimeter trail	Alternative deleted.	N/A
14b	Limited perimeter trail, platforms, kiosks	More signage and rebuilt pier added. The perimeter trail would be limited to those areas which did not impact sensitive habitat.	Figure 19 – Recreational Elements Locations
18	Watershed educational display	Alternative deleted.	N/A

5.1 *REMEDIATION ALTERNATIVES*

Remediation alternatives generally include:

- Implementing changes to the tidal connection between Colorado Lagoon and Marine Stadium.
- Removing contaminated sediment.
- Treating storm water and dry season low flow runoff into the lagoon.
- Mitigating flooding potential.
- Improving beach sand nourishment practices.
- Reducing other sources of potential pollutants entering the lagoon.

This study identified potential sources of sediment and pollutants entering the lagoon. The assumptions made regarding the non-point source loads were:

- Most metals of concern are attached, absorbed or discrete particles found in sediment.
- Most PAHs are associated with oil and grease from vehicles parked, stored, or driven within the watershed. It is an air pollutant subject to deposition as well as a liquid or sludge that leaks or is discharged by the vehicle. Sediment can become coated with or absorb PAHs.
- DDT and its degradation by-products are legacy pollutants and are transported by dust and air particulates. Deposition and subsequent sediment transport by dry and wet weather flows causes any new accumulation in the Colorado Lagoon. The neighborhood around the Colorado Lagoon is well-established and there is a small possibility of unknown residential storage and potential illegal use or disposal of this substance.
- PCB is a legacy pollutant and transported by dust and air particulates. Deposition and subsequent sediment transport by dry and wet weather flows causes any new accumulation in the Colorado Lagoon.
- Pesticides and herbicides may contain small amounts of organo-pesticides that are absorbed on sediment or removed by water during landscape irrigation.
- Excess nitrogen and phosphorus compounds found in fertilizers are absorbed on sediment or dissolved in by water during landscape irrigation.
- Overwatering, parking lot wash down, untreated storm water from construction sites, and other dry and wet weather flows on streets transport pollutants to the storm drains and to the Colorado Lagoon in sediment, as soluble constituents, or as immiscible liquids.

Further investigation could lead to better identification of the pollutant and sediment sources and thus the ability to reduce and control them before they enter the Colorado Lagoon. The proposed tasks for this investigation are provided in the Next Phase SOW deliverable. These proposed tasks include testing samples in upstream storm drains with the intent of identifying sections of the watershed area that are potential pollutant sources. It was also requested that further sediment sampling be completed in the swimming area

of the lagoon. The tasks associated with this are also provided in the Next Phase SOW deliverable.

Figure 3 summarizes the remediation alternatives related to the treatment of all eleven storm drains entering the lagoon. This figure is based on the existing storm drain system, i.e. without implementation of the proposed Termino Avenue Drain Project. Figures 4 and 5 revise this approach to take into account the proposed alternative for the TADP with the outlet remaining in the lagoon. It is assumed that if remedial actions can be successful at improving water quality with the TADP outlet at Colorado Lagoon, then the actions will also be successful under the scenario of the TADP connected to Marine Stadium.

In order to determine the success of the remediation alternatives after they have been implemented, a preliminary set of target goals shown in Table 4 is proposed. The lagoon would be monitored before and after alternatives implementation and the goals would establish reference points to evaluate their success.

Table 4. Proposed Remediation Target Goals

Measured Parameter	Target Goal	Monitoring Frequency
Bacteria	Do not exceed AB411 criteria during dry season, morning hours, swim area, wading depth.	Weekly
Contaminants in Sediment (Metals, PAHs, DDTs, PCBs, Chlordane, Dieldrin)	Do not exceed Probable Effects Levels (PELs)*, with the exception of DDE which should be measured against the ERM.	Once annually for five years. Assess at three years.
Litter	No litter accumulated at/near the culvert.	Monthly
Dissolved Oxygen	≥ 5 mg/L, at depth of 3-5 feet, averaged across three samples in a given location, three locations total.	Monthly
Algae Blooms	No algae blooms that cover more than 25% of the lagoon between March 21 – June 21 (Spring).	Once per Spring
Sediment	Minimal change to lagoon bathymetry, as measured by the change in the lagoon's storage capacity (requires bathymetric survey and subsequent analysis).	Once every ten years.
Plants	See Appendix C.	See Appendix C.
Birds	Increase number and diversity of birds. Specific goals include increasing the number of shorebirds that use the lagoon and increasing the diversity of land birds particularly non-urban adapted species.	Once per season
Fish	Increase number of juvenile California halibut.	Two times per year

Measured Parameter	Target Goal	Monitoring Frequency
Invertebrates	Increase number of taxa in the western arm to more than 15** and increase Shannon-Wiener Diversity index in the west arm to greater than 1.5, by five years following completion of remediation.	Once annually
Eelgrass	Establish one or more eelgrass beds in the lagoon.	Two times per year
Spring Tidal Range	Increase the average spring tidal range by between 1 and 2 feet from the existing 3.5 feet. Measurements can occur using a staff mounted within the lagoon or a tide meter.	Twice per month
Turbidity	Decrease turbidity throughout the lagoon to levels that visually compare to those of Marine Stadium using simple qualitative observations at several locations.	Weekly

**PELs (and TELs) were originally developed by MacDonald et al. 1992 based upon the Weight of Evidence approach. This approach was a modification of the original method for ERLs and ERM first proposed by Long and Morgan (1990). PELs and other sediment and water quality objectives were summarized by the Coastal Protection & Restoration Division of NOAA (Buchman, 1999) to provide a convenient reference for preliminary screening purposes. PELs used for this document were based upon the values summarized by Buchman (1999). At the current time, specific criteria do not exist for 303(d) delisting and so the PELs are thought to be the most reasonable and supportable values to use as target levels for Colorado Lagoon. In most cases, the PEL is between the ERL and ERM level.*

***This target goal was established based on the number of taxa currently found in other parts of the lagoon – 18 taxa in the northern arm and, 26 in the central lagoon area.*

It is important to point out that none of the target goals above address monitoring bioaccumulation in fish or invertebrates (the 303(d) list includes the Colorado Lagoon for DDT, chlordane, dieldrin and PCBs in tissue). The Environmental Protection Agency and the State are working on these issues, but little progress has been made regarding monitoring parameters and thus there is not a straight-forward bioaccumulation parameter to monitor at this time.

5.2 RESTORATION ALTERNATIVES

The second phase of project implementation should begin after some or all of the remediation alternatives have been implemented. Once the contaminated sediments have been removed, the sources of pollutants have been addressed, and tidal flushing has been improved, then restoration of a healthy ecosystem can begin.

The restoration alternatives generally involve:

- Restoration and creation of natural upland, intertidal and marine habitats.
- Recontouring slopes to provide an expanded intertidal zone.
- Removal of non-native plants.

- Native plant landscaping around the perimeter of the lagoon.
- Creation of vegetated buffers and swales and reconfiguration of some of the existing infrastructure to isolate the lagoon from the golf course.
- Installation of additional recreational elements (e.g. limited perimeter trail, educational displays) to enhance public enjoyment of the lagoon.

The Colorado Lagoon provides a unique opportunity for creating an under-represented habitat type in this region. As stated before, migrating and wintering shorebirds have large energy needs and limited areas where they can forage without human disturbance. Significant human disturbance occurs on many of the beaches in Southern California and is very harmful to shorebirds because it limits the time they can feed. Intertidal mudflats within estuaries have been greatly reduced in Southern California because the vast majority of estuaries have been filled for development or dredged to make harbors. Therefore, the creation of intertidal mudflat habitat at Colorado Lagoon and implementation of measures to protect it to the extent possible represents a significant benefit to migrating and wintering shorebirds.

Consideration was given to the potential to attract Belding's savannah sparrows, a State-listed endangered species to the site. Belding's savannah sparrows are dependent upon the existence of pickleweed habitat. The measures envisioned to expand and improve pickleweed habitat would increase the chances that the Colorado Lagoon could attract the Belding's savannah sparrow. However, even with improved pickleweed habitat, the amount of habitat available at Colorado Lagoon is probably too small to support a viable population. Furthermore, breeding sparrows at the lagoon would be vulnerable to small mammalian predators including cats, dogs and raccoons. If Belding's savannah sparrows do start breeding at Colorado Lagoon, the U.S. Fish and Wildlife Service should be consulted about additional measures that might be taken to protect them, while maintaining the overall goal and objectives of the restoration project.

5.3 RANKING OF ALTERNATIVE COMPONENTS BY PROJECT OBJECTIVES

Table 5 provides a comparison of how well each alternative meets the defined project objectives, as identified by the project team. It is acknowledged that this comparison and subsequent ranking is partially subjective in nature. The number of high, medium and low ratings were counted for each alternative and used to develop a ranking.

5.3.1 Remediation Alternatives

The ranking for the remediation-related alternatives is proposed as follows. There is no significance to the order in which the alternatives are listed within each category.

Highest Ranking

- Alternative 1a. Clean culvert, repair tidal gates, optimize their function, and remove structural impedances.
- or*
- Alternative 1c. Utilize existing culvert and build open channel between the lagoon and Marine Stadium. It should be noted that a variation of this alternative would be to first clean the culvert and evaluate the improvement. If it is deemed that cleaning

the culvert does not result in the desired improvement, the open channel alternative would be developed.

High Ranking

- Alternative 11. Install treatment bio-swale outlets for the smaller concrete drains into the lagoon.
- Alternative 12. Construct low flow and first flush diversions to the sanitary sewer and in-line trash separation devices for selected storm drains.
- Alternative 2. Remove contaminated sediment in the western arm via excavation by berming off the western end.
- Alternative 3. Remove contaminated sediment in the central lagoon via excavation and recontour the central lagoon bed if additional testing indicates this action is warranted.

Medium Ranking

- Alternative 15. Implement/improve trash management protocols, without including a debris boom.
- Alternative 13. Eliminate golf course 7th hole long tee.
- Alternative 17b. Modify sand nourishment practices.

Lowest Ranking

- Alternative 9. Construct a flood protection dike to protect from flooding near Eliot/Colorado Street corner.
- Alternative 16. Implement bird management protocols.

5.3.2 Restoration Alternatives

The ranking for the restoration-related alternatives is as follows. There is no significance to the order in which the alternatives are listed within each category

Highest Ranking

- Alternative 5a. Remove exotic vegetation and plant native vegetation, with no slope recontouring, for the following areas.
 - i) Western tip of west arm - remove grass and plant native vegetation.
 - ii) Eastern shore of west arm - remove non-native shrubbery and plant native vegetation.
 - iii) Northern tip of north arm - remove grass and plant native vegetation. Create naturalized park area with native plantings.
 - iv) Eastern shore - remove iceplant and plant native vegetation buffer.
 - v) Southern shore – plant low shrubs between concrete path and sand (near playground) and along Appian Way between parallel-parking area and sand (near lifeguard station). Also plant low shrubs between grass and sidewalk along Colorado Street adjacent to playground and picnic area. Remove asphalt and plant trees along Appian Way where current asphalt strip exists between the road and the lagoon access road parking area.

or

- Alternative 5b. Recontour side slopes and create mudflat intertidal habitat along entire eastern shore, western shore of north arm, and along western arm, and do all of 5a above.

High Ranking

- Alternative 7c/d. Move golf course fenceline, move/narrow access road and north shore parking lot (and use permeable pavement), and create upland zone along western shore of north arm, swale along northern shore golf course fenceline, bermed sandy intertidal zone along northern shore, and bird island in western arm.

Medium Ranking

- Alternative 14b. Install limited perimeter trail, viewing platforms /overlooks and telescopes, with interpretative kiosks. Rebuild pier and platform to the west of the lifeguard station.

Lowest Ranking

Alternative 6. Create/improve sandy intertidal habitat along southern shore of west arm.

These rankings should be considered along with the ranking according to cost provided in the following section.

5.4 RANKING OF ALTERNATIVE COMPONENTS BY COST

Alternatives are ranked below by cost for both construction and maintenance. These costs have been updated from the *Development and Evaluation of Restoration Alternatives* report (M&N, 2004d) to reflect the alternative revisions discussed in Section 4.2. The detailed cost sheets for each of these alternatives were provided in the previous report. Updated cost sheets are provided in Appendix D for those alternatives that have been revised. It should be noted that these costs are not additive, as some of these alternatives are “either/or” types of options.

5.4.1 Construction Costs

Table 6 lists each of the alternative components based on an estimate of construction cost, with the least expensive alternative listed first in each of the remediation and restoration categories. Construction costs shown in spreadsheets include costs for environmental review and permitting, so these items should be broken out of the estimate when applying for funding to construct.

Table 5. Comparison of Alternative Components to Project Objectives

Colorado Lagoon Restoration Alternatives Comparison to Project Objectives										
Alternative Components	Description	Redirect, reduce, or treat storm and dry weather runoff to minimize contamination of water and sediment	Identify sources of pollutants and recommend controls within the watershed	Evaluate the need to remove contaminated sediments	Restore and maintain estuarine habitat	Improve lagoon's circulation and tidal connection with Marine Stadium and Alamos Bay	Balance flood control, recreation, and pollution abatement at Colorado Lagoon	Enhance public enjoyment of Colorado Lagoon	Create a sediment management plan for imported beach fill sand	Address next phase implementation funding*
Remediation-Related Alternative Components										
1a	Clean Existing Culvert	M	L	L	H	H	M	M	L	H
1c	Open Channel Plus Existing Culvert	M	L	L	H	H	M	M	L	H
2	Remove Sediment - Western Arm	L	L	H	H	L	M	L	L	M
3	Remove Sediment - Central Area	L	L	H	H	L	M	L	L	M
9	Flood Dike	L	L	L	L	L	H	L	L	M
11	Storm Drain Outlet Bio-Swales	H	M	L	H	L	M	L	L	H
12	Storm Drain Low Flow Diversion and In-line Trash Separation Device Installation	H	M	L	H	L	M	L	L	H
13	Eliminate 7th Hole Long Tee	L	H	L	M	L	M	L	L	M
15	Trash Management	M	H	L	M	L	M	L	L	M
16	Bird Management	L	H	L	L	L	M	L	L	L
17b	Modify Sand Nourishment	L	M	M	L	L	M	L	H	L
Restoration-Related Alternative Components										
5a	Remove Non-Native Plants and Revegetate with Native Plants (without slope recontouring)	L	L	L	H	L	M	H	L	H
5b	Recontour Steep Slopes (except by culvert), Revegetate with Native Plants	L	L	L	H	L	M	H	L	H
6	Western Arm South Shore Sandy Habitat	L	L	L	H	L	M	L	L	M
7c/d	Move Fenceline Back, Bio-Swale and Vegetated Buffer Along Fenceline, Berm on North Beach, Island in Western Arm.	M	M	L	H	L	M	M	L	H
14b	Limited Perimeter Trail, Viewing Platforms, Rebuilt Pier	L	L	L	M	L	M	H	L	L
* This assessment is based on criteria from the SB 750 (Machado) state bond fund.										
Legend:										
H	High correlation to project objective. Alternative directly relates to objective.									
M	Medium correlation to project objective. Alternative indirectly relates to objective.									
L	Low correlation to project objective. Alternative does not affect objective.									

Table 6. Ranking of Alternative Components by Construction Cost

Alternative Components	Description	Construction Costs
Remediation-Related Alternative Components		
13	Eliminate 7th Hole Long Tee	\$0
17b	Modify Sand Nourishment	\$16,000
16	Bird Management	\$21,000
15	Trash Management	\$26,000
9	Flood Dike	\$34,000
11	Storm Drain Outlet Bio-Swales	\$100,000
1a	Clean Existing Culvert	\$170,000
2	Remove Sediment - Western Arm	\$630,000
3	Remove Sediment - Central Area	\$1,200,000
12	Storm Drain Low Flow Diversion and In-line Trash Separation Device Installation	\$2,981,000
1c	Open Channel Plus Existing Culvert	\$3,500,000
Restoration-Related Alternative Components		
6	Western Arm South Shore Sandy Habitat	\$110,000
5a	Remove Non-Native Plants and Revegetate with Native Plants (without slope recontouring)	\$323,000
14b	Limited Perimeter Trail, Viewing Platforms, Rebuilt Pier	\$447,000
7c/d	Move Fenceline Back, Bio-Swale and Vegetated Buffer Along Fenceline, Berm on North Beach,	\$582,000
5b	Recontour Steep Slopes (except by culvert) and Revegetate with Native Plants	\$609,000

* It is assumed that costs to remove the long tee for Alternative 13 are not incurred by the project, but by the golf course operator.

5.4.2 Maintenance Costs

Table 7 lists each of the alternative components, based on an estimate of maintenance costs, with the least expensive alternative listed first.

Table 7. Ranking of Alternative Components by Maintenance Cost

Alternative Components	Description	Annual Maintenance Costs
Remediation-Related Alternative Components		
2	Remove Sediment - Western Arm	\$0
3	Remove Sediment - Central Area	\$0
13	Eliminate 7th Hole Long Tee	\$0
11	Storm Drain Outlet Bio-Swales	\$200
16	Bird Management	\$300
9	Flood Dike	\$4,000
15	Trash Management	\$7,000
17b	Modify Sand Nourishment	\$8,000
1a	Clean Existing Culvert	\$15,000
1c	Open Channel Plus Existing Culvert	\$33,000
12	Storm Drain Low Flow Diversion and In-line Trash Separation Device Installation	\$52,000
Restoration-Related Alternative Components		
6	Western Arm South Shore Sandy Habitat	\$0
5a	Remove Non-Native Plants and Revegetate with Native Plants (without slope recontouring)	\$8,000
5b	Recontour Steep Slopes (except by culvert) and Revegetate with Native Plants	\$9,000
7c/d	Move Fenceline Back, Bio-Swale and Vegetated Buffer Along Fenceline, Berm on North Beach,	\$13,000
14b	Limited Perimeter Trail, Viewing Platforms, Rebuilt Pier	\$25,000

5.4.3 Use of Volunteers to Implement Restoration

Colorado Lagoon is not unique in that it possesses an active local stakeholder group, but it may be somewhat unique from other sites in that the local stakeholders are extremely active in enacting change to, and maintenance of the site. Restoration actions at the lagoon will cost a certain amount of money, with greater costs for more extensive actions and vice-versa. Site maintenance will also require funds. Using volunteers to implement certain restoration actions and maintenance and monitoring may reduce costs. This study assumed no use of volunteer labor to construct and maintain alternatives so the most conservative costs are estimated. Conservative cost estimates are more reliable for purposes of budgeting and applying for grants, both of which the City may eventually have to perform. So the real costs of construction and maintenance of alternatives may actually be lower than estimated to the benefit of the City, but responsible planning dictates use of the assumption that volunteer labor is not available.

5.5 *RANKING OF ALTERNATIVES CONSIDERING ALL FACTORS*

Alternatives have been ranked according to meeting project objectives and for costs to construct and maintain them. Considering all factors together yields a relatively clear vision of the alternatives that may be most suitable for high priority status versus those that could be implemented at later dates if funding is not initially available for implementation of the entire Master Plan.

5.5.1 Ranking of Remediation Alternatives

Consideration of all information shows that the following alternatives should be given highest priority for remediation and be implemented in this order:

1. Alternative 1a – Clean Existing Culvert (and optimize tide gate operations);
2. Alternative 2 – Sediment Removal in Western Arm and possibly Alternative 3 – Sediment Removal in Central Area, (depending on the outcome of additional sediment testing specified in subsequent sections of this report);
3. Alternative 17b - Modify Sand Nourishment;
4. Alternative 11 – Install Storm Drain Outlet Bio-Swales;
5. Alternative 12 – Install Storm Drains Low Flow Diversion and Trash Separation Devices; and
6. Alternative 1c – Construct Open Channel Plus Utilize Existing Culvert in the event that Alternative 1a does not accomplish the desired improvement to water quality.

The following alternatives should be given lower priority for remediation and can be implemented in any order as appropriate given funding and approval constraints:

1. Alternative 13 – Eliminate 7th Hole Long Tee;
2. Alternative 9 – Install Flood Dike;
3. Alternative 15 – Trash Management; and
4. Alternative 16 - Bird Management.

5.5.2 Ranking of Restoration Alternatives

Considering all available information shows that the following alternatives should be given highest priority for restoration and be implemented in this order:

1. Alternative 6 – Western Arm Sandy Habitat; and
2. Alternative 5b – Recontour Steep Slopes (Except by Culvert) and Revegetate.

The following alternatives should be given lower priority for restoration and can be implemented in any order as appropriate given funding and approval constraints:

1. Alternative 7d – Move Fenceline Back, Swale and Vegetated Buffer Along Fenceline, Berm on North Beach, Island in Western Arm; and
2. Alternative 14b – Limited Perimeter Trail, Viewing Platforms.

6.0 CONCLUSION / NEXT STEPS

6.1 CONCLUSIONS

Comprehensive field studies, reviews of existing data, and collaboration with TAC members, City Staff, and public stakeholders have resulted in a feasible set of alternatives to address the Colorado Lagoon restoration objectives. This Restoration Feasibility Report presents a broad set of alternatives developed to address all project objectives, a shortened list for implementation, and their ranking. The alternatives were developed as individual components to select, prioritize, and implement either incrementally or in total as funding becomes available.

Alternatives can be implemented individually to enact solutions and be complementary to one another, or they can be implemented collectively as part of a Master Plan. Alternatives are prioritized for importance in the case that they cannot be implemented in total. To facilitate prioritization, the alternatives are categorized herein as relating to either remediation or restoration of the lagoon. Implementation of remediation alternatives prior to implementation of those related to restoration is a sound approach to establish a viable habitat community. There is one exception, however, in that the grading for restoration Alternative 6 (creation of sandy intertidal on south shore of western arm) would be least costly if it was done at the same time as the remediation Alternative 2 (removal of sediment in western arm). Additionally, it is recommended that Alternative 1a (culvert cleaning and removal of impedances) be implemented immediately and the results monitored in order to provide guidance on the need for further remediation.

This project addresses the issues that were identified as significant for consideration at the outset of the study, and identifies additional issues to resolve. These issues will be addressed as part of the next phase of project implementation. The tasks for addressing each of these issues are included in the separate “Scope of Work for Next Phase of Restoration Plan” deliverable submitted together with this final report.

6.2 *NEXT STEPS*

Specifically, the recommended course of action for restoration in the near-term includes the steps and tasks listed below. The order of approach should generally start with Step 1 (either whole or in part), and move through subsequent steps. However, the order can vary after Step 1 depending on results of the Step 1 data analyses and/or the availability of funding. For instance, if funding presently exists for implementation of one or more particular alternatives and it is determined that those actions do not require permitting or environmental review, the City can proceed to Step 3 (either in whole or in part as funding allows), and then directly to Steps 5, 6 and 7.

9. Perform data gathering and analyses to fill five data gaps, not necessarily in this order:
 - a. Identification of sources of sediment and contaminants from the watershed;
 - b. Classification of contaminants in the lagoon sediment between the western arm and the central lagoon (in the vicinity of the foot bridge), where samples were not taken as part of this study, to understand how to most effectively implement Alternative 3;
 - c. Identification of the existence and location of sills at the ends of the culvert, or impedances within it, to understand how to most effectively implement Alternative 1a;
 - d. Quantification of potential impounding of storm flows in the upstream storm drain system as a future consequence of implementation of the proposed flood dike (Alternative 9); and
 - e. Consideration of further action to address the beach erosion/gully problem from storm runoff on the southern shore of the lagoon, just west of the lifeguard station if the plantings in Alternative 5a or 5b are not effective to solve the problem.
10. Apply for funding to implement and monitor the performance of the preferred alternatives (presented in Section 4.3 of this report).
11. Design and implement a pre-restoration monitoring plan to document the baseline values of the monitoring parameters listed below and included in Table 4 with target goals, and that can be continued into the future after restoration to measure restoration success and enable adaptive management:
 - a. Tidal elevations in the lagoon over time;
 - b. Dissolved oxygen levels in the lagoon over time and with depth;
 - c. General pollutant trends in lagoon water and sediment over space and time based on existing sampling or possibly slightly more extensive sampling;
 - d. General turbidity levels in lagoon waters over space and time based on visual observations; and
 - e. General habitat areas throughout the lagoon over space and time.
12. Perform environmental review and permitting of the preferred alternatives.

13. Perform final engineering for construction of the preferred alternatives.
14. Implement Alternative 1a coupled with monitoring of tides, turbidity, and bacteria and dissolved oxygen levels. If monitoring indicates desired improvements to these variables does not occur, pursue implementation of Alternative 1c.
15. Based on results of data analyses in Step 1 above, implement Alternative 2 and possibly Alternative 3 or a modified version thereof as appropriate.
16. Implement all other preferred remediation and restoration alternatives as funding becomes available, including development of a sand management plan as part of Alternative 17b.

The State of California, City of Long Beach, and local stakeholders and interest groups have successfully completed the initial important step toward restoring the very valuable and sensitive public resource of Colorado Lagoon. This demonstrated cooperation, determination and perseverance of involved parties may enable the ultimate vision of the restored lagoon to become a reality.

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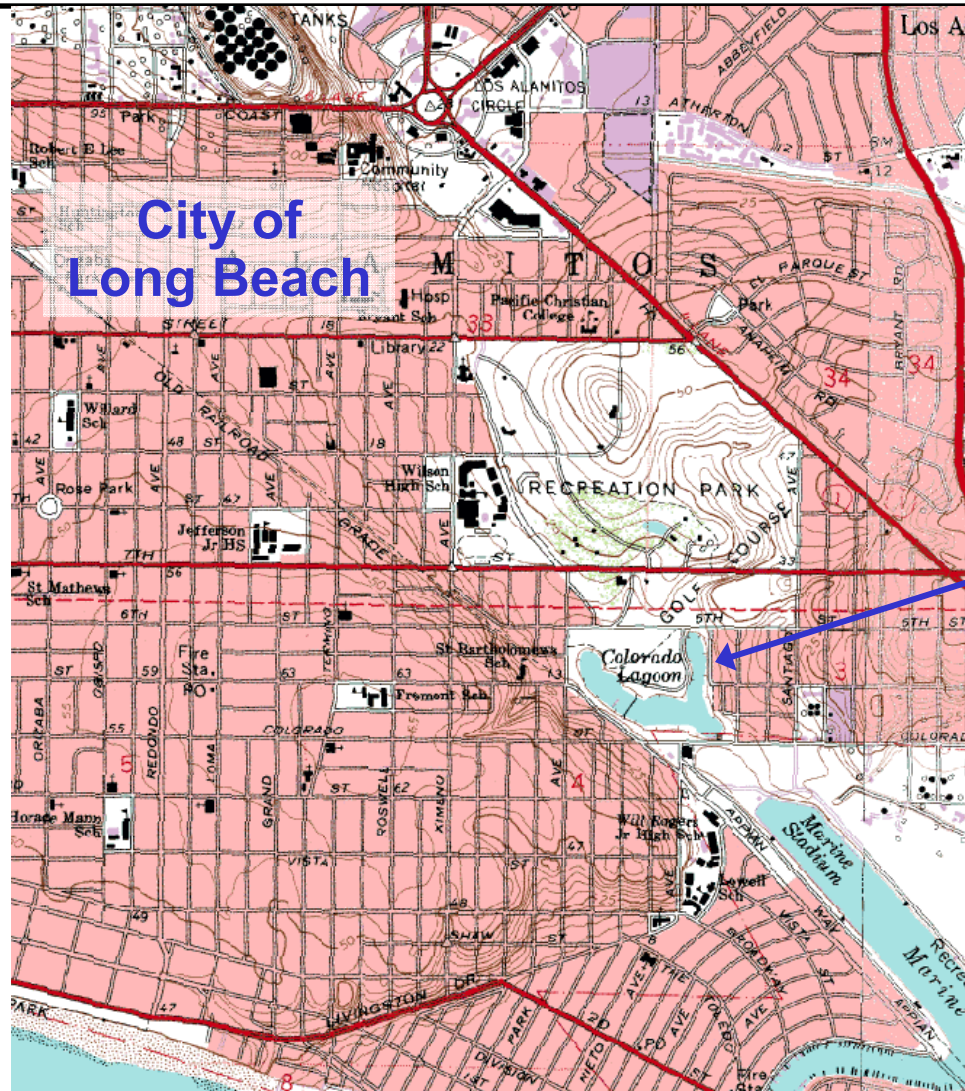
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Colorado Lagoon

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January 2005

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**Colorado Lagoon Restoration
Feasibility Study**

Vicinity Map

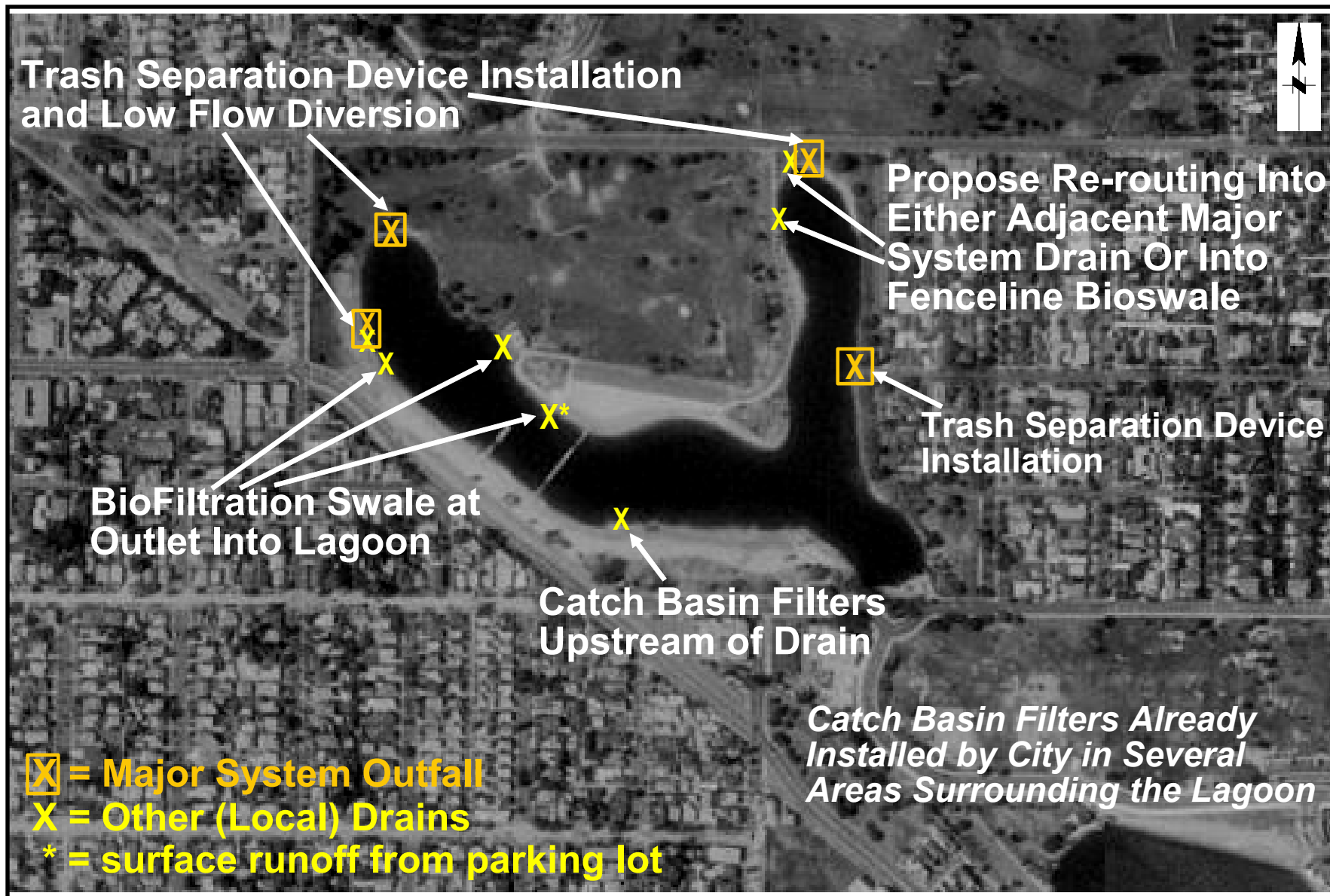
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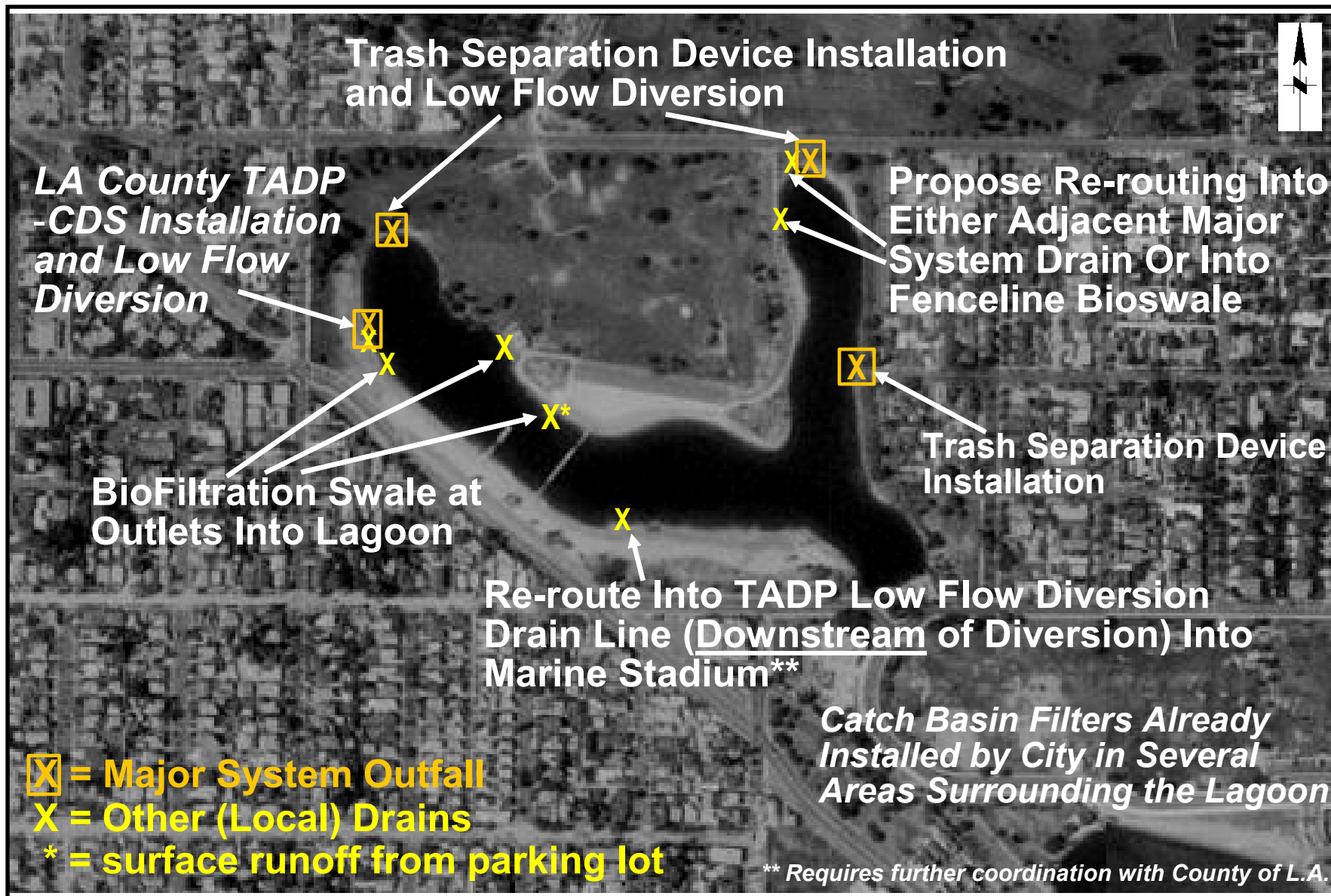


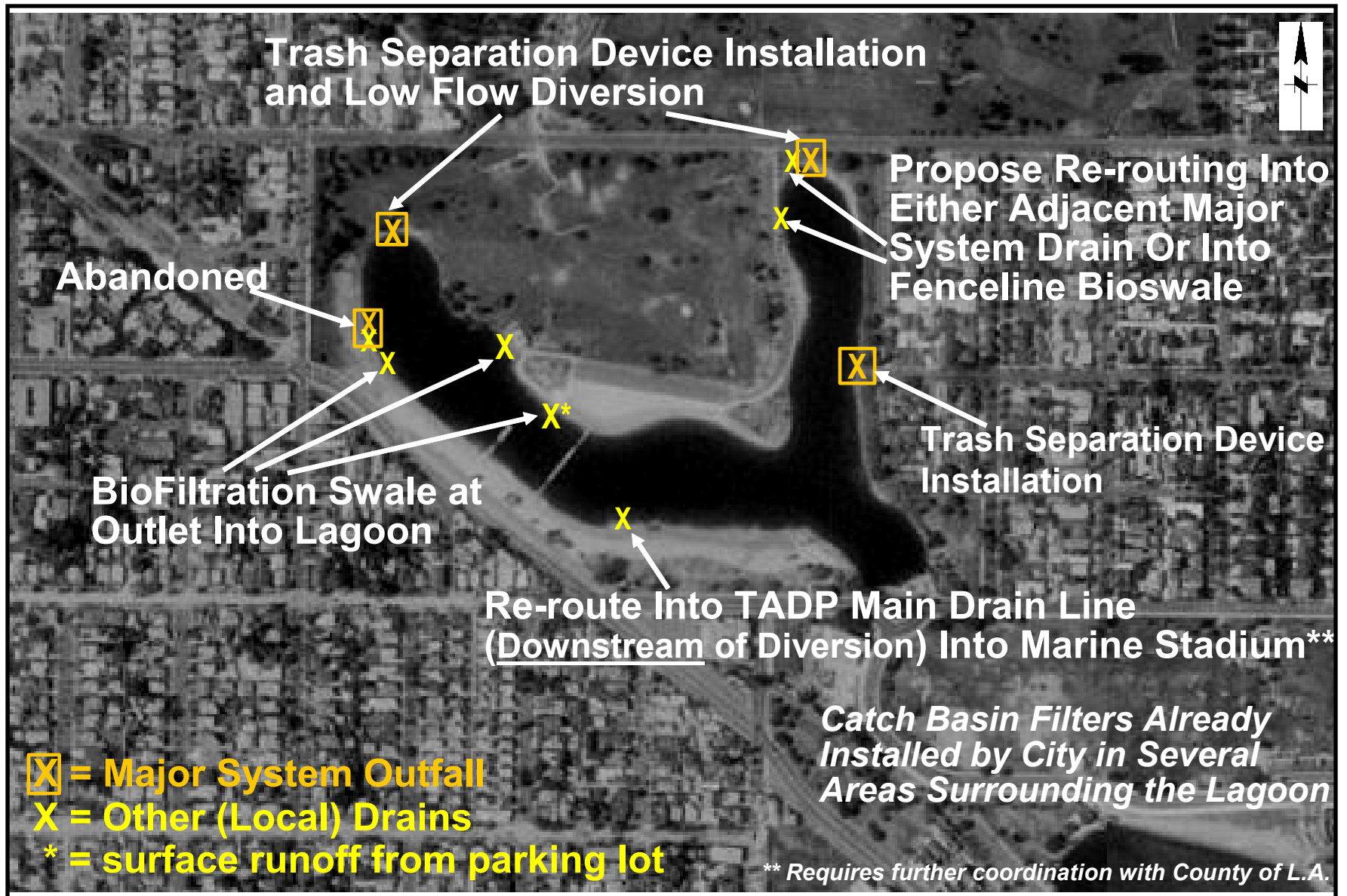
**Colorado Lagoon Restoration
Feasibility Study**

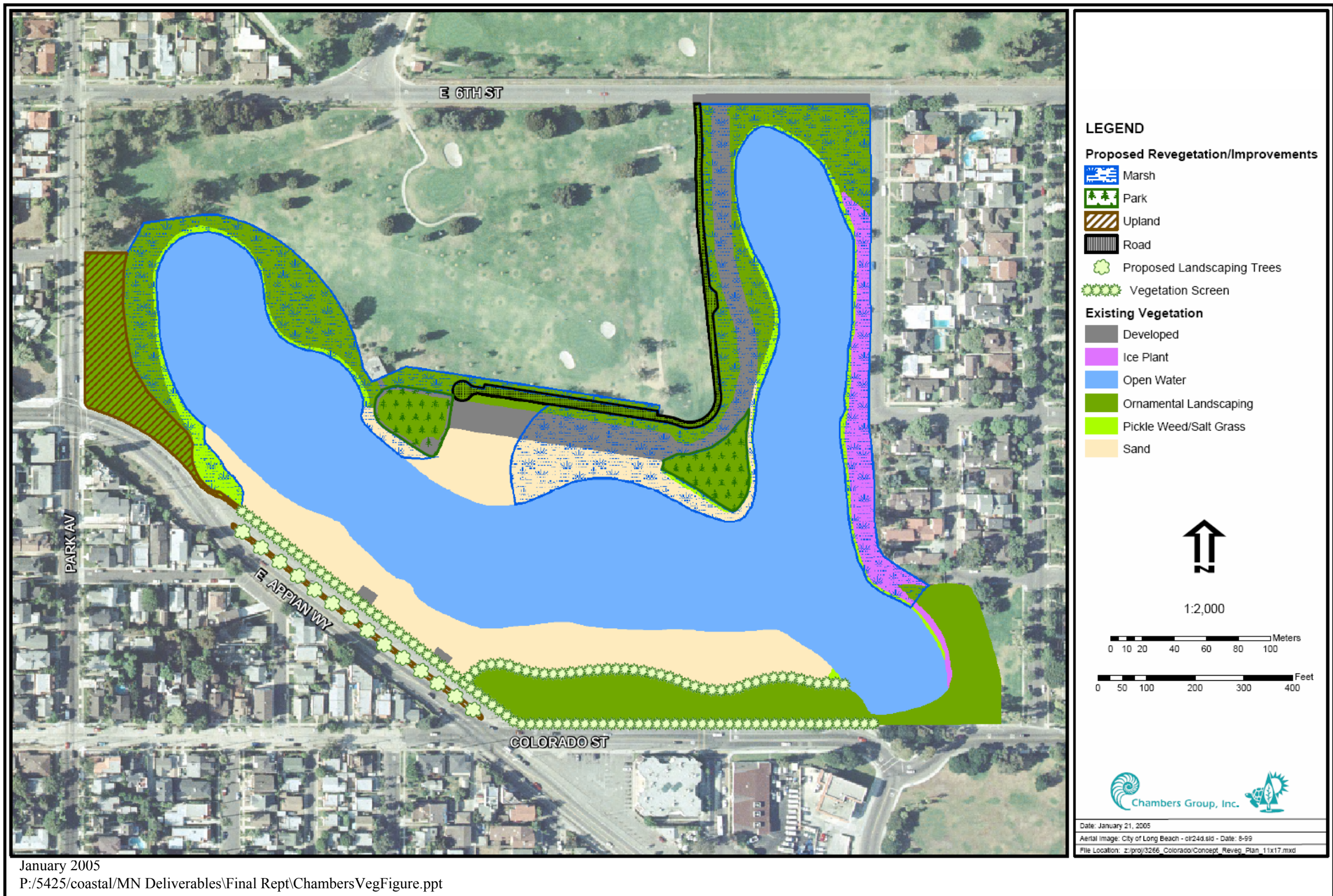
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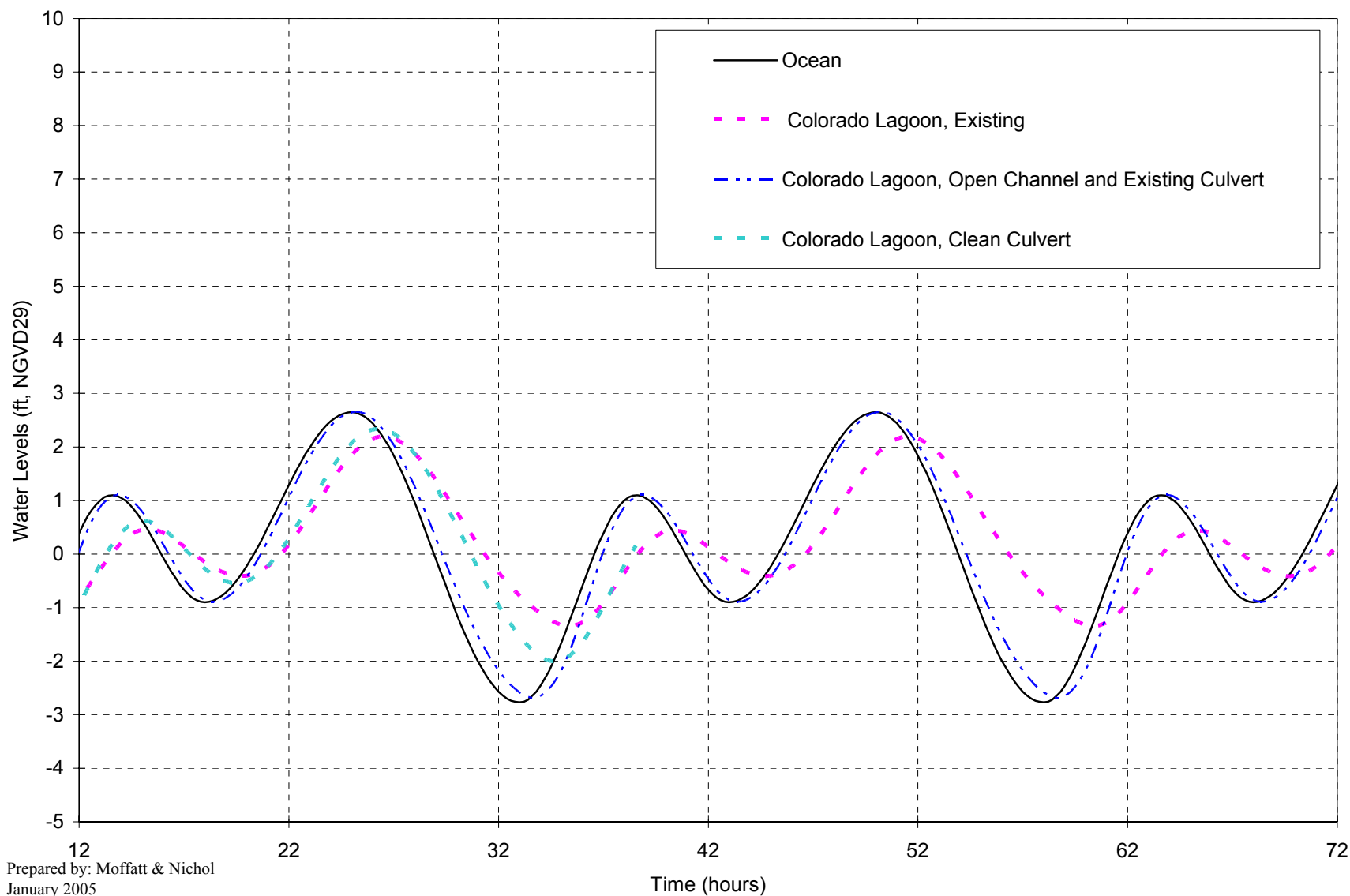
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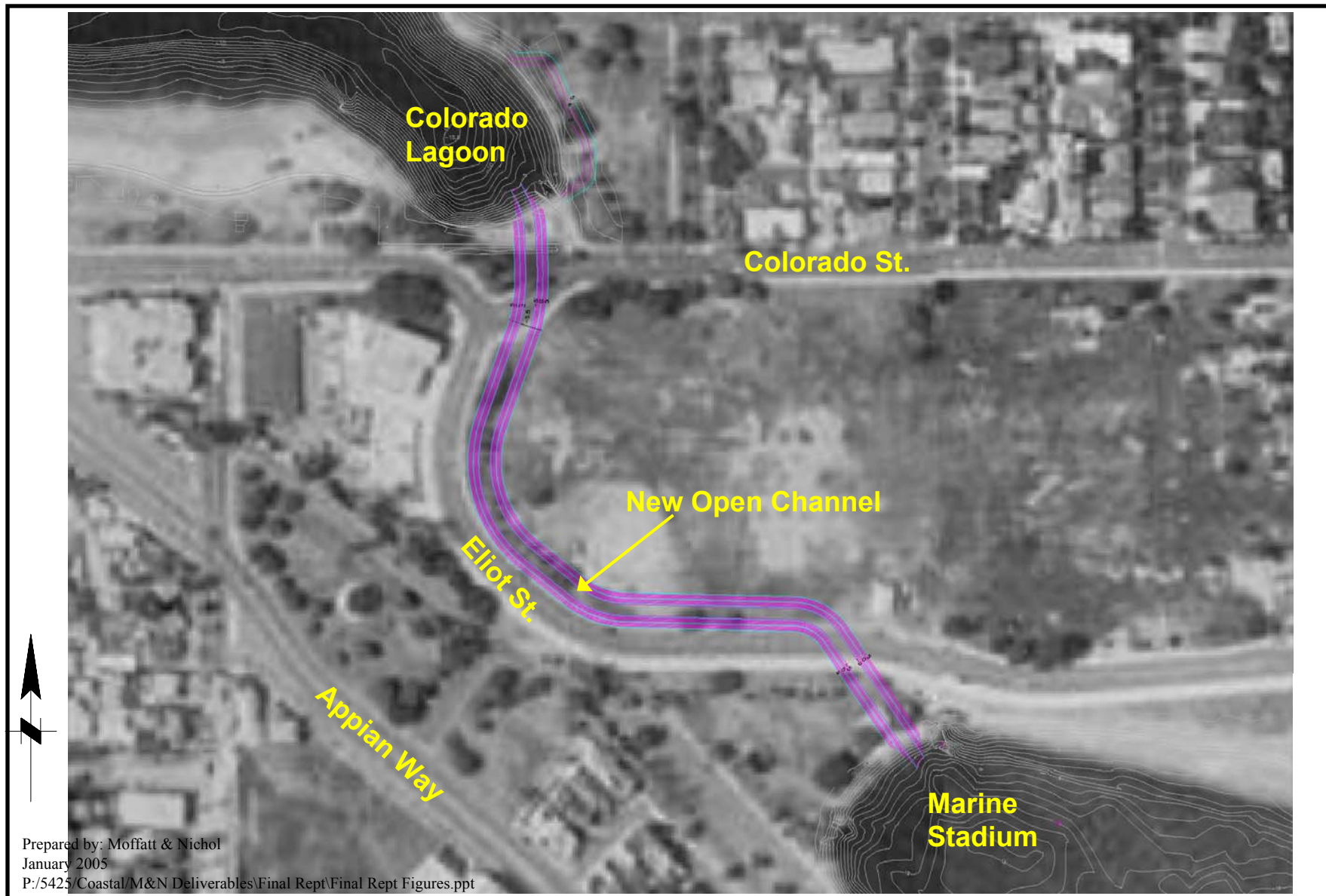




**Colorado Lagoon Restoration
Feasibility Study**

Tidal Elevations for Average Spring Tides

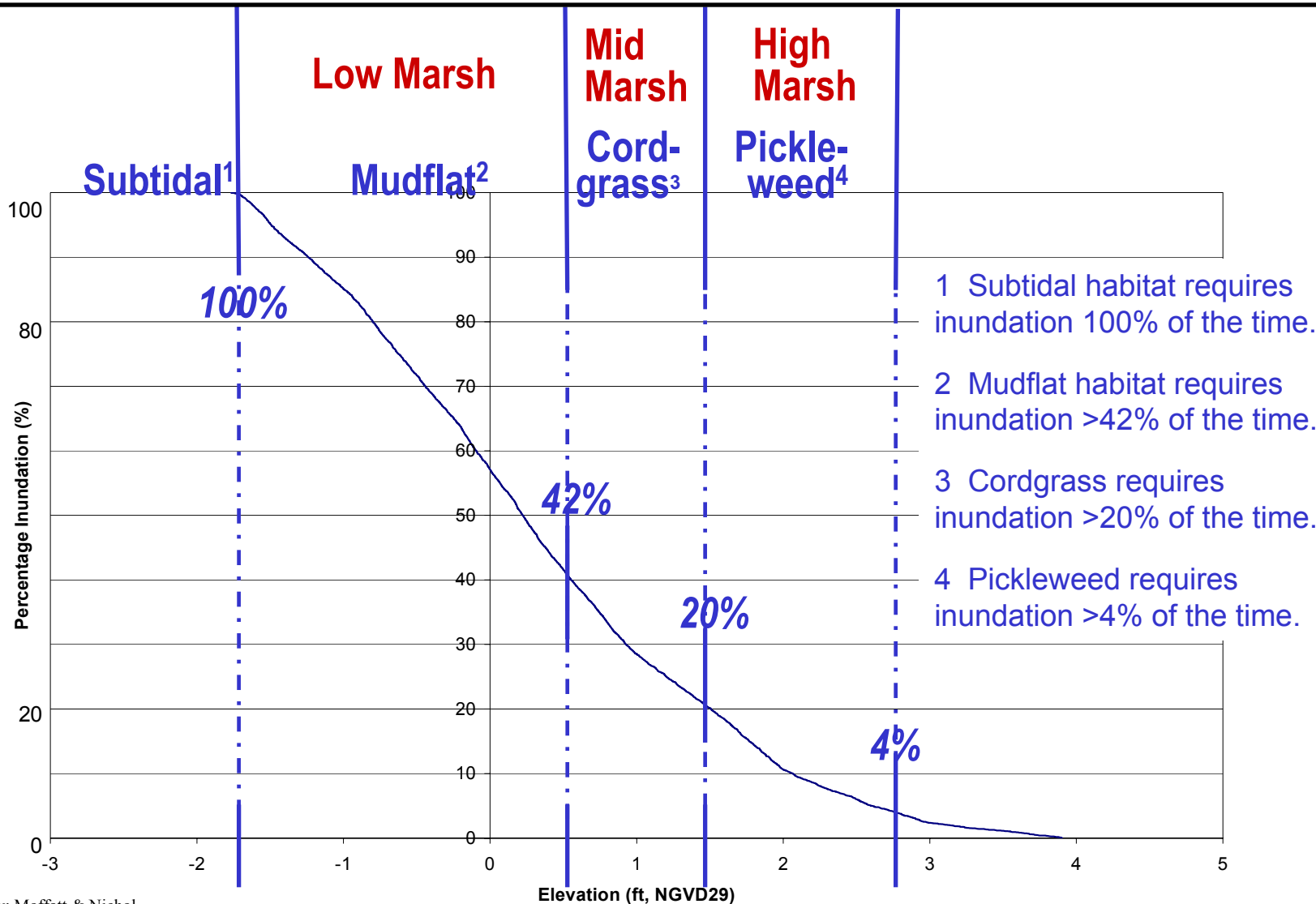
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**Colorado Lagoon Restoration
Feasibility Study**

Conceptual Grading Plan – Open Channel

**Figure
8**



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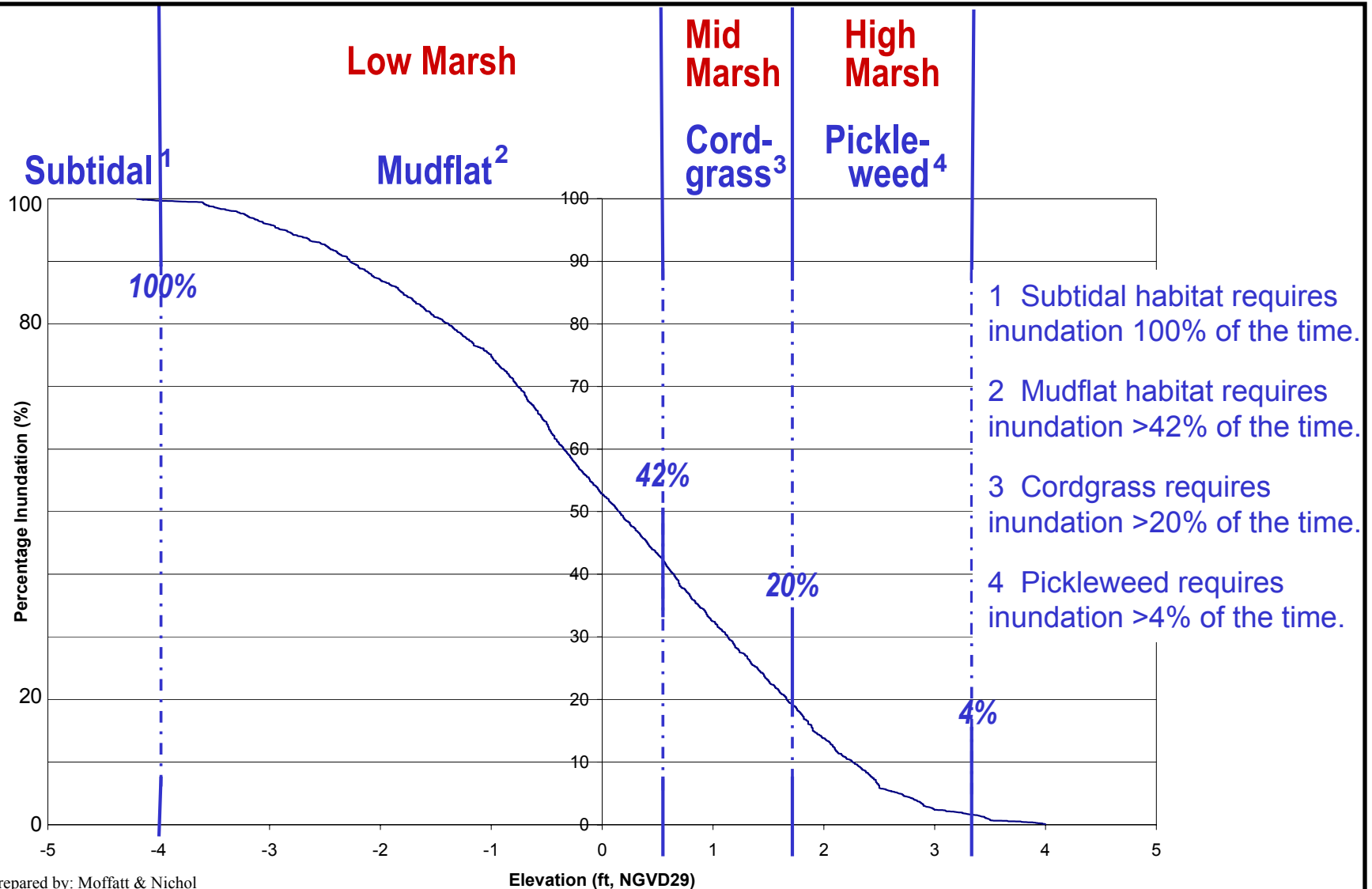
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**Colorado Lagoon Restoration
Feasibility Study**

Inundation Curve With Existing Conditions

**Figure
9**



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**Colorado Lagoon Restoration
Feasibility Study**

Inundation Curve With Open Channel

**Figure
10**

Pink denotes areas of sediment removal

**Alternative 2
- Western Arm**

**Alternative 3
- Central Lagoon**

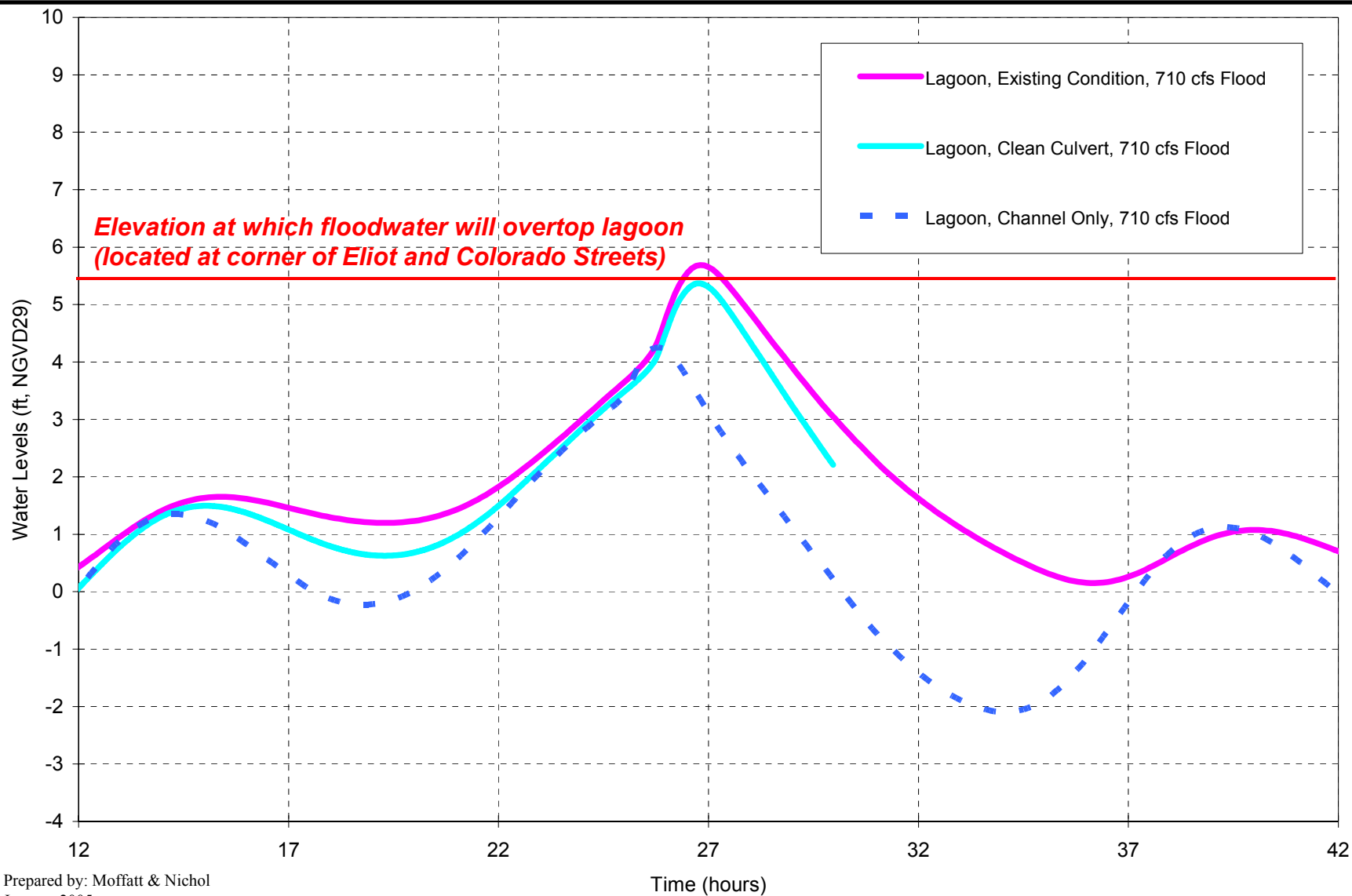
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**Colorado Lagoon Restoration
Feasibility Study**

Conceptual Grading Plan – Sediment Removal

**Figure
11**



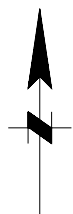
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**Colorado Lagoon Restoration
Feasibility Study**

Storm Flood Water Surface Elevations

**Figure
12**



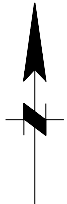
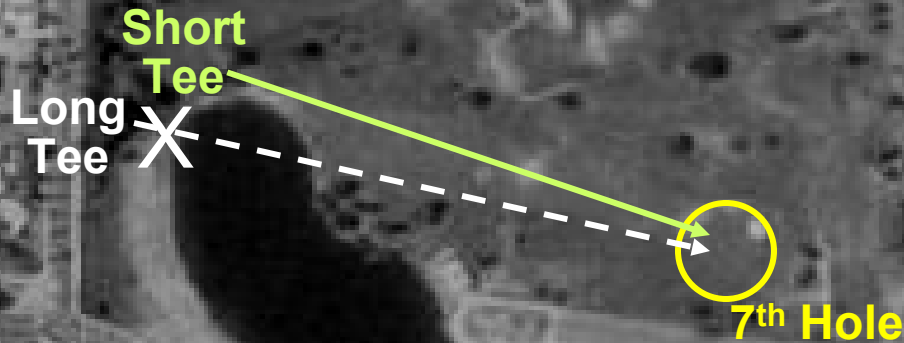
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**Colorado Lagoon Restoration
Feasibility Study**

Conceptual Flood Dike Location

**Figure
13**

**Eliminate the Long Tee and
Move it to the Short Tee**



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**Colorado Lagoon Restoration
Feasibility Study**

Conceptual Modification of the Tee to 7th Hole

**Figure
14**



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**Colorado Lagoon Restoration
Feasibility Study**

Existing and Proposed Sand Placement Areas

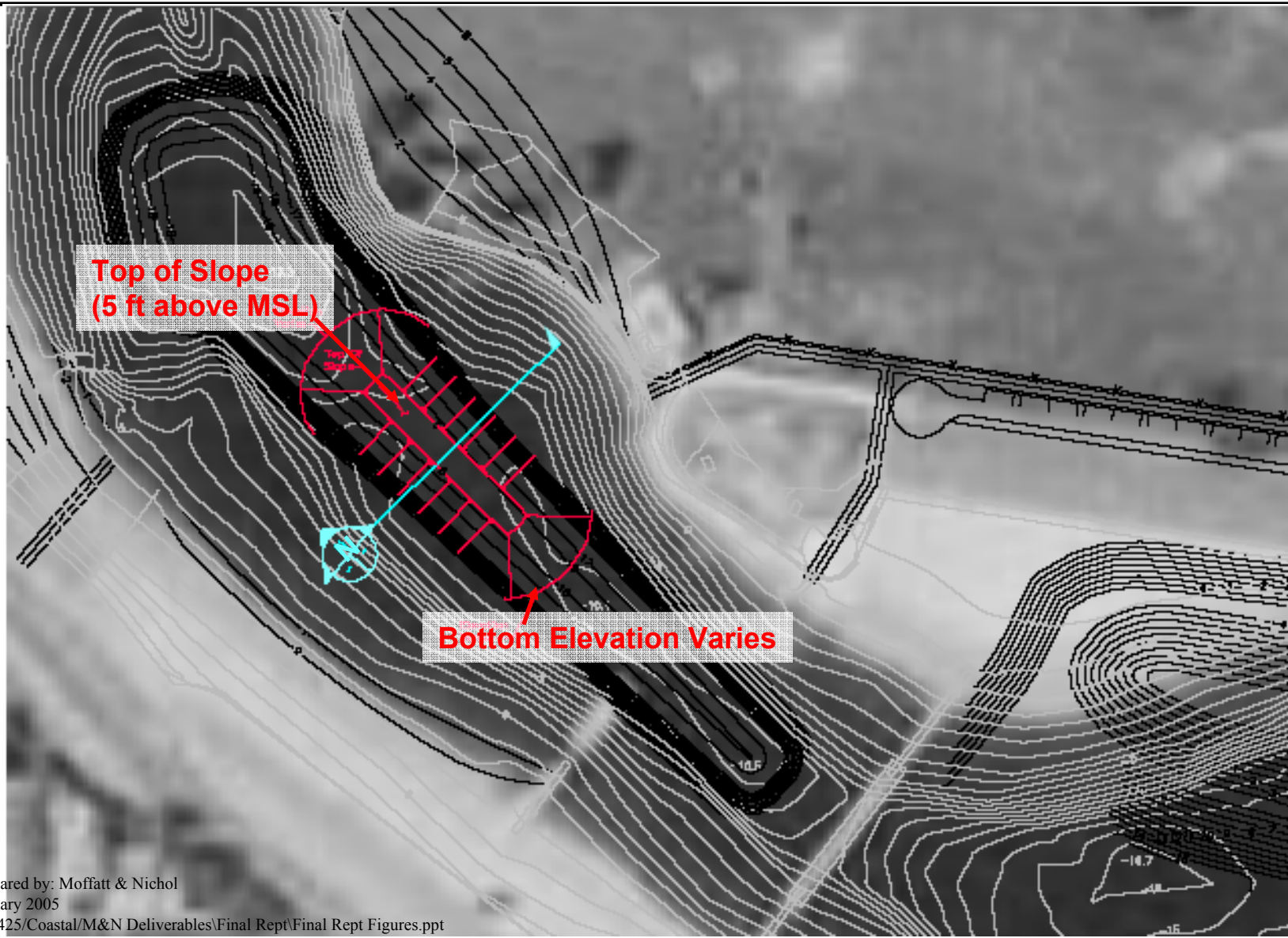
**Figure
15**



**Colorado Lagoon Restoration
Feasibility Study**

**Alternative 7c/d – North Shore Changes
with Island in Western Arm**

**Figure
16**

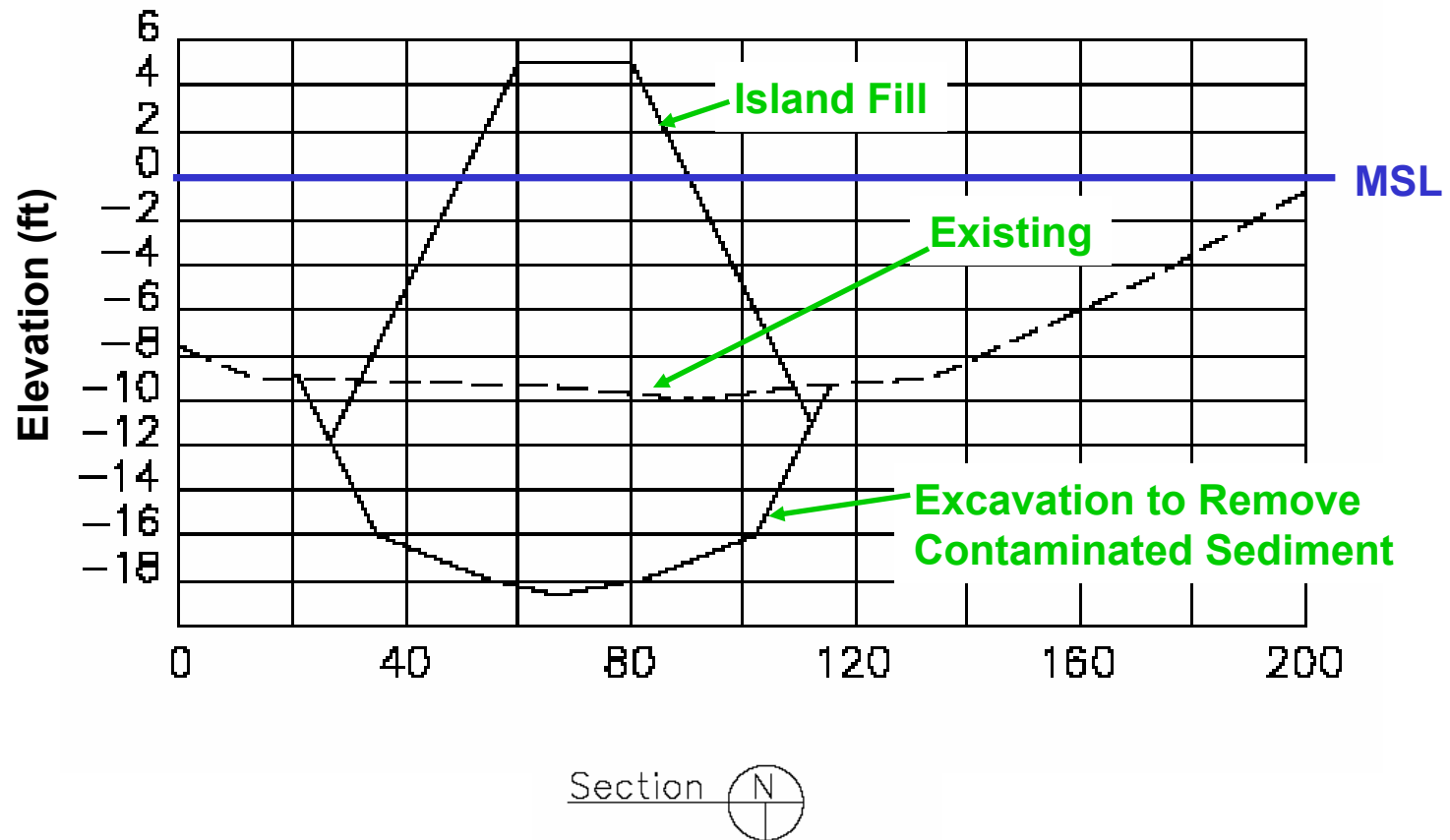


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**Colorado Lagoon Restoration
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Conceptual Grading Plan – Western Arm Island

**Figure
17**



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**Colorado Lagoon Restoration
 Feasibility Study**

Typical Cross Section – Western Arm Island

**Figure
 18**



Appendix A
Alternatives Analyses Matrix

Colorado Lagoon Restoration Alternative Components Analysis										
Components	Description	Infrastructure Changes	Environmental Benefits	Environmental Impacts	Habitat Changes	Hydrologic Regime	Flood Impacts	Maintenance Needs	Construction Costs	Annual Maintenance Costs
Existing Conditions	No Changes	None beyond those existing	None beyond those existing	None beyond those existing	None	Tide range of: 4.5 feet; tidal residence time of: 1.6 days longer than Marine Stadium; tidal prism of: 64.4 ac ft; restricted tidal flushing	Maximum flood elevation at lagoon of: 5.7; requires erection of flood protection dike along Colorado St.	None	\$0	\$0
<i>Improve Circulation and Tidal Connection</i>										
1a	Clean Existing Culvert	Remove sills at each end; repair mechanical gates	Improved circulation and water quality, and reduced floodwater elevations	Removal of marine habitat colonized within culvert; temporary construction impacts of noise and exhaust impacts from equipment	Loss of fouling community in culvert, improved health and diversity of lagoon aquatic community	Tide range of: 5.9 feet; tidal residence time of: 1.0 day longer than Marine Stadium; tidal prism of: 64.4 ac ft; less restricted tidal flushing	Maximum flood elevation at lagoon of 5.2; dike still recommended along Colorado St.	Maintain and repair tide gates; remove debris and biofouling; clear trash rack	\$170,000	\$15,000
1c	Open Channel Plus Existing Culvert	Same as open channel; assumes no cleaning of existing culvert (not necessary)	The greatest improvement to water circulation and water quality, and most reduced floodwater elevations	Same as above; less direct public access to recreational fields; temporary construction impacts of traffic from detouring and trucking, and of noise and exhaust from equipment; possible impact to eelgrass at Marine Stadium	Improved aquatic habitat in lagoon.	Tide range of: 7.9 feet; tidal residence time of: 0.5 days longer than Marine Stadium; tidal prism of: 105.8 ac ft; least restricted tidal flushing	Maximum flood elevation at lagoon of: 3.8; requires no flood protection dike along Colorado St.	Maintain and repair tide gates; remove debris and biofouling; clear trash rack; repair revetment; maintain bridge, fence, signs; remove trash from channel	\$3,500,000	\$33,000
<i>Evaluate the need to remove contaminated sediments</i>										
2	Remove Sediment Western Arm	Assumes the west lagoon lagoon arm is drained and dried - excavate 15,300 cy of sediment	Eliminates a significant environmental hazard and removes the lagoon from the 303d list; assumed to improve benthic conditions	Temporary construction impacts to: fish and benthic habitat and birds; of dewatering, noise, exhaust and traffic impacts from equipment and trucking; 3-year impact to impoverished benthic community from removing sediment.	Improved diversity of benthic and fish community in west arm.	No effect	No effect	None	\$630,000	\$0
3	Remove Sediment Central Area	Excavate 34,700 cy of sediment	Eliminates compromised sediment; may improve benthic conditions	More extensive temporary construction impacts to: fish and benthic habitat; of dewatering, noise, exhaust and traffic impacts from equipment and trucking; 3-year impact to larger benthic community from removing sediment; eelgrass removed. Possible temporary impacts to least tern foraging habitat.	No change	No effect	No effect	None	\$1,200,000	\$0
<i>Identify pollutant sources and recommend controls in the watershed</i>										
15	Trash Management	None	Reduces direct contribution of litter to the lagoon	None	Minor improvement to water quality and thus habitat	No effect	No effect	None	\$26,000	\$7,000
16	Bird Management	None	Reduces direct contribution of bird feces (bacteria) to the lagoon	None	Minor improvement to water quality and thus habitat	No effect	No effect	None	\$21,000	\$300
<i>Restore and maintain estuarine habitat</i>										
5a	Revegetate	Remove non-native vegetation; plant native vegetation	Upland habitat improvement, trash screen along Colorado St. and Appian Way	Temporary construction impacts of noise, traffic, birds and exhaust from equipment and trucking	0.9 acres native upland/transitional, 3.1 acres marsh	No effect	No effect	Remove weeds	\$323,000	\$8,000
5b	Recontour steep slopes (except by culvert) and Revegetate	Flatten side slopes at all steep sides except near culvert; Remove non-native vegetation; plant native vegetation	Intertidal habitat expansion and improvement; upland habitat improvement, trash screen along Colorado St. and Appian Way	More extensive temporary construction impacts of noise, traffic, birds, invertebrates and exhaust from equipment and trucking; loss of grassy park areas	0.9 acres native upland/transitional, 3.1 acres marsh	No discernible effect; likely minor increase in tidal prism and increase in residence time	Minor indiscernible benefit of flood elevation reduction by incrementally increasing flood storage volume	Remove weeds	\$609,000	\$9,000
6	Western Arm South Shore Sandy Habitat	Flatten low side slope along sandy beach west of beach to create more bird habitat area	Expansion and improvement to foraging shore bird habitat	Temporary construction impacts from dewatering, and of noise and exhaust from equipment; possibly traffic if soil trucked away	0.4 acres of mid marsh	No discernible effect; likely minor increase in tidal prism and increase in residence time	Minor indiscernible benefit of flood elevation reduction by incrementally increasing flood storage volume	None	\$110,000	\$0
7c/d	Move Fenceline Back, Bio-Swale and Vegetated Buffer Along Fenceline, Berm on North Beach, Island in Western Arm.	Move fence and parking lot north; narrow parking lot & install permeable surface; vegetated buffer along south fence; vegetated swale south of buffer to capture and filter drainage prior to reaching lagoon; berm along north beach for sandy habitat protection; sand island off north beach as bird refuge	Further expansion of upland and buffer habitat (less disturbance to lagoon habitat); capture and filter drainage from golf course prior to reaching the lagoon; screen golf course from lagoon habitat areas; create protected shorebird habitat at north beach and isolated shorebird habitat on island.	More extensive temporary construction impacts of noise, traffic and exhaust from equipment and trucking, and reduced access; narrows fairways to 7th and 8th holes to constrain play,possible creation of mosquito breeding habitat if drainage were inadequate	2.9 acres of marsh	No discernible effect; likely minor increase in tidal prism and increase in residence time.	No effect	Remove weeds; maintain fence, permeable pavement, berm and island.	\$582,000	\$13,000

Colorado Lagoon Restoration Alternative Components Analysis										
Components	Description	Infrastructure Changes	Environmental Benefits	Environmental Impacts	Habitat Changes	Hydrologic Regime	Flood Impacts	Maintenance Needs	Construction Costs	Annual Maintenance Costs
Flood Control										
9	Flood Dike	Install low earthen berm along Colorado St. @ Eliot to prevent flood overtopping	Protects surrounding areas south of the lagoon from flooding from lagoon overtopping during the 50-year return storm	Temporary construction impacts of noise, traffic and exhaust from equipment and trucking	None	No effect	Maintains flood protection for areas outside of lagoon to the south for existing conditions; potential minor impact to upstream storm drains	None	\$34,000	\$4,000
Redirect or treat storm and low flows to minimize contamination of water and sediment.										
11	Storm Drain Outlet Bio-Swales	Demolish existing small local hard drain outlets; install earthen swales at outlets	Treats runoff from multiple small drains prior to reaching the lagoon	Temporary construction impacts of noise, traffic and exhaust from equipment and trucking, possible creation of mosquito breeding habitat if drainage were inadequate	Minor improvement to water quality and thus habitat	No effect	No effect	Remove weeds	\$100,000	\$200
12	Storm Drain Low Flow Diversion and In-line Trash Separation Device Installation	New wet well storage basin, diversion structures and trash separation devices installed at storm drain outlets, diversion lines to sewer trunk line, catch basin filter installation for swim area storm drains.	Diverts nuisance low flows and first-flushes to the sanitary sewer system, filters trash and debris during storm events.	Temporary construction impacts of noise, traffic and exhaust from equipment and trucking	Minor improvement to water quality and thus habitat	No effect	No effect	Service diversion structures and trash separation devices to remove debris	\$2,981,000	\$52,000
13	Eliminate 7th Hole Long Tee	Close long tee; only use short tee	Precludes driving of golf balls over the western arm and ball litter problem	Shortens drive to 7th hole and reduces the quality of that golf experience	Improves benthic habitat	No effect	No effect	None	\$0	\$0
Enhance public enjoyment										
14b	Limited Perimeter Trail, Viewing Platforms, Rebuilt Pier	Raised structures and graded mounds for views	Provides improved vantage points and interpretation for the public	Temporary construction impacts of noise, traffic and exhaust from equipment and trucking, and reduced access	No change	No effect	No effect	Maintain pier, trails, platforms/overlooks, interpretive signs, and telescopes	\$447,000	\$25,000
Create sediment management plan for imported beach fill sand										
17b	Modify Sand Nourishment	Import and place sand at beach, but modified work	Maintains recreational beach in suitable condition, with less lagoon sedimentation in the center	Temporary construction impacts of noise, traffic and exhaust from equipment and trucking, and reduced access	No change	No discernible effect; likely minor decrease in tidal prism and decrease in residence time	Minor indiscernible effect of reducing flood storage volume at lagoon	Deliver sand and regrade beach, rake and groom smaller area	\$16,000	\$8,000

Appendix B

BMP versus Pollutant

WATERSHED BMP	POLLUTANT(S) THAT MAY BE REDUCED	POLLUTANT TO BE MONITORED IN PLAN?
Construction site BMPs (reference www.cabmphandbooks.com/construction.asp , CASQA, 2003)	Sediment	Yes
	Metals	Yes
	PAH and Organo- Pesticides (DDT, chlordane, dieldrin)	Yes
Public education and outreach BMPs (including commercial sites) (reference www.cabmphandbooks.com/municipal.asp , CASQA, 2003))	Sediment	Yes
	Metals	Yes
	PAH and Organo- Pesticides (DDT, chlordane, dieldrin)	Yes
Reduce residential and golf course lawn overwatering.	Phosphorus, Nitrogen	No, although will monitor algae blooms and dissolved oxygen as indicators
	Bacteria	Yes
Pesticide/herbicide/fertilizer management plan at golf course.	Phosphorus, Nitrogen	No, although will monitor algae blooms and dissolved oxygen as indicators
	Organo-Pesticides (DDT, chlordane, dieldrin)	Yes
Increase City street sweeping.	Litter	Yes
	Bacteria	Yes
	Sediment	Yes

Appendix C
Vegetation Monitoring Plan (Draft)

Success Criteria

The success criteria for revegetation plans are described below. If at any time plantings in this area do not appear to be meeting the performance standards set forth in the restoration plan, the Landscape Contractor will be responsible for taking action and timely remedial actions (as determined by the Restoration Specialist) to ensure compliance with the performance standards.

Vegetation Performance Standards

Coastal bluff scrub, coastal brackish marsh/coastal salt marsh, and ornamental landscaping/vegetation screen are the target vegetation communities for the restoration. Listed below are the height standards and cover/survival standards that apply to all shrub plantings and seeding efforts.

Target for Coastal Bluff Scrub Restoration

Plantings shall have a minimum of 60 percent survival the first year and 70 percent survival thereafter, and/or shall attain 70 percent cover after 5 years. During performance monitoring percent survival and cover will be estimated by visual ocular estimates of each restoration area. Representative areas within the restoration areas will be also photographically documented from fixed stations. If the survival and cover requirements have not been met, replacement plantings shall be implemented, as necessary, to achieve the required standards. Replacements will be monitored with the original plantings during the 5-year monitoring period with the same survival and growth requirements as the plantings.

The survival and cover standards for the coastal sage scrub plantings are summarized in Table C-1.

Table C-1
Performance Standards for Coastal Bluff Scrub Plantings

Species	1 st Year	3 rd Year	5 th Year ¹
Shrubs	60% survival	70% survival	70% survival 60% cover
Seed Mixes ²	30% cover	None	None
¹ Performance standards during Year 5 must be attained without human interference (irrigation, rodent control)			
² If adequate germination is not attained to prevent erosion or exclude weed infestations, reseeded may be necessary.			

Target For Coastal Brackish Marsh/Coastal Saltwater Marsh Restoration

Plantings shall have a minimum of 60 percent survival the first year and 70 percent survival thereafter, and/or shall attain 70 percent cover after 5 years. During performance monitoring percent survival and cover will be estimated by visual ocular estimates of each restoration area. Representative areas within the restoration areas will be also photographically documented from fixed stations. If the survival and cover requirements have not been met, replacement plantings shall be implemented, as necessary, to achieve the required standards. Replacements will be monitored with the original plantings during the 5-year monitoring period with the same survival and growth requirements as the plantings.

The survival and cover standards for the coastal brackish marsh and coastal saltwater marsh plantings are summarized in Table C-2.

Table C-2

Performance Standards for Coastal Brackish Marsh/Coastal Saltwater Marsh Plantings

Species	1st Year	3rd Year	5th Year¹
Shrubs	60% survival	70% survival	70% survival 60% cover
Seed Mixes ²	30% cover	None	None
¹ Performance standards during Year 5 must be attained without human interference (irrigation, rodent control)			
² If adequate germination is not attained to prevent erosion or exclude weed infestations, reseedling may be necessary.			

Target For Ornamental Landscaping/Vegetation Screen Emplacement

Plantings within the vegetation screen areas shall have a minimum of 70 percent survival the first year and 100 percent survival thereafter, in order to maintain an adequate amount of screening.

Plantings of trees between the parking lot and Appian Way shall have 100 percent survival to maintain visual aesthetic.

During performance monitoring, survival will be estimated by visual ocular estimates. Representative areas will be also photographically documented from fixed stations. If the survival requirements have not been met, replacement plantings shall be implemented, as necessary, to achieve the required standards. Replacements will be monitored with the

original plantings during the 5-year monitoring period with the same survival requirements as the plantings.

Vegetation Monitoring Methods

Monitoring will be performed by the Restoration Specialist or a qualified biologist with appropriate experience in site monitoring and transect measurements.

Performance monitoring of vegetation within the restoration areas will generally include (1) estimation of total percent cover by desired and weedy species for all restoration areas through visual reconnaissance, and (2) detailed analysis of growth, cover, height and viability through a minimum of 5-percent sampling of each plant palette within the restoration areas using quadrant and line intercept methods. Photographic records will be kept of all restoration areas for purposes of comparing earlier and later stages of plant establishment and growth.

Appendix D
Updated Cost Estimate Spreadsheets
- Construction Estimates

CONSTRUCTION COST ESTIMATE
Item 1b - Build Meandering Open Channel



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$100,000.00	\$100,000
2	Clear and Grub Surface (including tree removal)	52,500	SF	\$0.75	\$39,375
3	Temporary Protective Fence	7500	LF	\$ 3.00	\$22,500
4	Demolish Existing Roadways	420	SY	\$4.00	\$1,680
5	Detour Traffic	1	LS.	\$15,000.00	\$15,000
6	Dewater Excavation Area	1	LS.	\$20,000.00	\$20,000
7	Excavate Channel	12,500	CY	\$6.00	\$75,000
8	Install Two Bridges to Replace Existing Roadways	5,640	SF	\$175.00	\$987,000
9	Reroute Utilities	1	LS.	\$24,600.00	\$24,600
10	Install Utility Line Conduit to Prevent Future Spills	1	LS.	\$16,200.00	\$16,200
11	Concrete Channel Section at Marine Stadium Near Restroom	1	EA	\$457,500.00	\$457,500
12	Relocate Ball Fields	1	EA	\$5,000.00	\$5,000
13	Line Channel With Stone Rip-Rap	4,048	TON	\$50.00	\$202,381
14	Install New Fencing	2,100	LF	\$17.00	\$35,700
15	Install Swing Gates	2	EA	\$1,000.00	\$2,000
16	Install Signage	8	EA	\$500.00	\$4,000
17	Plug and Abandon Existing Culvert	194	SF	\$17.00	\$3,298
18	Haul Surplus Grub/Demo Material to a Conventional Landfill	2,000	TON	\$75.00	\$150,000
19	Haul Surplus Earth Material to the Port of Long Beach	12,500	CY	\$15.00	\$187,500
Subtotal Items					\$2,348,734
Contingency (25%)					\$587,183
Engineering, Design, Supervision, and Administration (15%)					\$352,310
Environmental Review (5%)					\$117,437
Permitting (5%)					\$117,437
TOTAL					\$3,523,101

ASSUMPTIONS

1. The existing culvert is plugged and abandoned in place without being removed.
2. The channel is excavated using conventional earthmoving equipment and dewatering is required.
3. The material excavated from the channel is not contaminated. This should be confirmed with an investigation.
4. Material is disposed of at the Port of Long Beach and trucking costs are \$40 per hour.
5. Tipping fees are \$50 per ton.
6. The construction period is two months.
7. Mobilization includes excavators, bulldozers, loaders, pumps and lines, and trucks.

CONSTRUCTION COST ESTIMATE
Item 1b - Build Straight Open Channel



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$100,000.00	\$100,000
2	Clear and Grub Surface (including tree removal)	44,100	SF	\$0.75	\$33,075
3	Temporary Protective Fence	7500	LF	\$ 3.00	\$22,500
4	Demolish Existing Roadways	420	SY	\$4.00	\$1,680
5	Detour Traffic	1	LS.	\$15,000.00	\$15,000
6	Dewater Excavation Area	1	LS.	\$20,000.00	\$20,000
7	Excavate Channel	10,500	CY	\$6.00	\$63,000
8	Install Two Bridges to Replace Existing Roadways	5,640	SF	\$175.00	\$987,000
9	Reroute Utilities	1	LS.	\$24,600.00	\$24,600
10	Install Utility Line Conduit to Prevent Future Spills	1	LS.	\$16,200.00	\$16,200
11	Concrete Channel Section at Marine Stadium Near Restroom	1	EA	\$457,500.00	\$457,500
12	Relocate Ball Fields	1	EA	\$5,000.00	\$5,000
13	Line Channel With Stone Rip-Rap	3,400	TON	\$50.00	\$170,000
14	Install New Fencing	1,764	LF	\$17.00	\$29,988
15	Install Swing Gates	2	EA	\$1,000.00	\$2,000
16	Install Signage	8	EA	\$500.00	\$4,000
17	Plug and Abandon Existing Culvert	194	SF	\$17.00	\$3,298
18	Haul Surplus Grub/Demo Material to a Conventional Landfill	1,680	TON	\$75.00	\$126,000
19	Haul Surplus Earth Material to the Port of Long Beach	10,500	CY	\$15.00	\$157,500
Subtotal Items					\$2,238,341
Contingency (25%)					\$559,585
Engineering, Design, Supervision, and Administration (15%)					\$335,751
Environmental Review (5%)					\$111,917
Permitting (5%)					\$111,917
TOTAL					\$3,357,512

ASSUMPTIONS

1. The existing culvert is plugged and abandoned in place without being removed.
2. The channel is excavated using conventional earthmoving equipment and dewatering is required.
3. The material excavated from the channel is not contaminated. This should be confirmed with an investigation.
4. Material is disposed of at the Port of Long Beach and trucking costs are \$40 per hour.
5. Tipping fees are \$50 per ton.
6. The construction period is two months.
7. Mobilization includes excavators, bulldozers, loaders, pumps and lines, and trucks.

CONSTRUCTION COST ESTIMATE
Item 1c - Use Existing Channel and Build Open Channel



COST IS SAME AS THAT FOR OPEN CHANNEL OPTION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$100,000.00	\$100,000
2	Clear and Grub Surface (including tree removal)	52,500	SF	\$0.75	\$39,375
3	Temporary Protective Fence	7500	LF	\$ 3.00	\$22,500
4	Demolish Existing Roadways	420	SY	\$4.00	\$1,680
5	Detour Traffic	1	LS.	\$15,000.00	\$15,000
6	Dewater Excavation Area	1	LS.	\$20,000.00	\$20,000
7	Excavate Channel	12,500	CY	\$6.00	\$75,000
8	Install Two Bridges to Replace Existing Roadways	5,640	SF	\$175.00	\$987,000
9	Reroute Utilities	1	LS.	\$24,600.00	\$24,600
10	Install Utility Line Conduit to Prevent Future Spills	1	LS.	\$16,200.00	\$16,200
11	Concrete Channel Section at Marine Stadium Near Restroom	1	EA	\$457,500.00	\$457,500
12	Relocate Ball Fields	1	EA	\$5,000.00	\$5,000
13	Line Channel With Stone Rip-Rap	4,048	TON	\$50.00	\$202,381
14	Install New Fencing	2,100	LF	\$17.00	\$35,700
15	Install Swing Gates	2	EA	\$1,000.00	\$2,000
16	Install Signage	8	EA	\$500.00	\$4,000
17	Plug and Abandon Existing Culvert	194	SF	\$17.00	\$3,298
18	Haul Surplus Grub/Demo Material to a Conventional Landfill	2,000	TON	\$75.00	\$150,000
19	Haul Surplus Earth Material to the Port of Long Beach	12,500	CY	\$15.00	\$187,500
Subtotal Items					\$2,348,734
Contingency (25%)					\$587,183
Engineering, Design, Supervision, and Administration (15%)					\$352,310
Environmental Review (5%)					\$117,437
Permitting (5%)					\$117,437
TOTAL					\$3,523,101

ASSUMPTIONS

1. The existing culvert is plugged and abandoned in place without being removed.
2. The channel is excavated using conventional earthmoving equipment and dewatering is required.
3. The material excavated from the channel is not contaminated. This should be confirmed with an investigation.
4. Material is disposed of at the Port of Long Beach and trucking costs are \$40 per hour.
5. Tipping fees are \$50 per ton.
6. The construction period is two months.
7. Mobilization includes excavators, bulldozers, loaders, pumps and lines, and trucks.

CONSTRUCTION COST ESTIMATE
Item 2 - Remove Contaminated Sediment in the Western Arm



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$75,000.00	\$75,000
2	Dewater Area 1	1	LS.	\$20,000.00	\$20,000
3	Excavate Area 1	15,320	CY	\$6.00	\$91,920
4	Haul Area 1 Material to the Port of Long Beach	15,320	CY	\$15.00	\$229,800
Subtotal Items					\$416,720
Contingency (25%)					\$104,180
Engineering, Design, Supervision, and Administration (15%)					\$62,508
Environmental Review (5%)					\$20,836
Permitting (5%)					\$20,836
TOTAL					\$625,080

ASSUMPTIONS

1. The west end of the west arm is drained, dewatered and excavated in the dry using conventional earthmoving equipment.
2. The material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 1 hour round-trip to the Port of Long Beach
3. Trucking costs are \$40 per hour.
4. No tipping fees are required
5. The construction period is three months.

COLORADO LAGOON MATERIAL DISPOSAL ANALYSES
Item 3 - Remove Compromised Sediment in the Central Lagoon



AREA 2 COMBINED RE-USE ON-SITE AND HAULED TO THE PORT OF LONG BEACH

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$75,000.00	\$75,000
2	Dewater Area 2	1	LS.	\$20,000.00	\$20,000
3	Excavate Area 2	34,700	CY	\$6.00	\$208,200
4	Re-Use Area 2 Material On-Site (Assuming a Capacity of One-Fourth of the Volume)	8,675	CY	\$9.00	\$78,075
5	Haul the Balance of Area 2 Material to the Port of Long Beach	26,025	CY	\$15.00	\$390,375
Subtotal Items					\$771,650
Contingency (25%)					\$192,913
Engineering, Design, Supervision, and Administration (15%)					\$115,748
Environmental Review (5%)					\$38,583
Permitting (5%)					\$38,583
TOTAL					\$1,157,475

ASSUMPTIONS

1. The lagoon is drained, dewatered and excavated in the dry using conventional earthmoving equipment.
2. The material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 1 hour round-trip to the Port of Long Beach
3. Trucking costs are \$40 per hour.
4. No tipping fees are required
5. The construction period is four months.

CONSTRUCTION COST ESTIMATE
Item 4 - Implement Watershed BMPs



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Construction Activities	1	LS.	\$0.00	\$0
2	Street Sweeping	1	LS.	\$0.00	\$0
3	Commercial Area Wash Down	1	LS.	\$25,000.00	\$25,000
4	Over Watering	1	LS.	\$80,000.00	\$80,000
5	Golf Course Herbicide/Pesticide Use	1	LS.	\$20,000.00	\$20,000
Subtotal Items					\$125,000
Contingency (25%)					\$31,250
Engineering, Design, Supervision, and Administration (5%)					\$6,250
Permitting (5%)					\$6,250
TOTAL					\$168,750

ASSUMPTIONS

1. All costs provided by HDR/CGVL.

CONSTRUCTION COST ESTIMATE
Item 5a - Remove Exotic Vegetation and Replace with Native



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$50,000.00	\$50,000
2	Clear and Grub	11,867	SY	\$0.75	\$8,900
3	Dispose of Refuse	1,780	TON	\$75.00	\$133,500
4	Install Upland Vegetation	2.64	AC	\$6,800.00	\$17,952
5	Install Irrigation	2	AC	\$2,475.00	\$4,950
Subtotal Items					\$215,302
Contingency (25%)					\$53,826
Engineering, Design, Supervision, and Administration (15%)					\$32,295
Environmental Review (5%)					\$10,765
Permitting (5%)					\$10,765
TOTAL					\$322,953

ASSUMPTIONS

1. The construction period is five months.
2. Mobilization is for a bulldozer and trucks.
3. Disposal of vegetative refuse occurs at a conventional landfill.
4. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
5. Trucking costs are \$40 per hour to Bee Canyon.
6. Tipping fee at the landfill is assumed to be \$50 per truck.



CONSTRUCTION COST ESTIMATE
Item 5b - Remove Exotic Vegetation and Replace with Native
Recontour Side Slopes to Enlarge Intertidal Habitat Areas
Along Western and Northern Arms and East Shore

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$75,000.00	\$75,000
2	Clear and Grub	11,867	SY	\$0.75	\$8,900
3	Dispose of Refuse	1,780	TON	\$75.00	\$133,500
4	Excavation and Grading	8,542	CY	\$12.00	\$102,504
5	Install Upland Vegetation	2.64	AC	\$6,800.00	\$17,952
4	Install Irrigation	2	AC	\$2,475.00	\$4,950
5	Install Wetland Vegetation	6.5	AC	\$7,290.00	\$47,385
6	Install Irrigation	6.5	AC	\$2,475.00	\$16,088
Subtotal Items					\$406,279
Contingency (25%)					\$101,570
Engineering, Design, Supervision, and Administration (15%)					\$60,942
Environmental Review (5%)					\$20,314
Permitting (5%)					\$20,314
TOTAL					\$609,418

ASSUMPTIONS

1. The construction period is five months.
2. Mobilization is for an excavator, bulldozer, grader, loader and trucks.
3. Surplus soil material is reused on-site to construct either the island or berms.
4. The construction period is three months.
5. Disposal of vegetative refuse occurs at a conventional landfill.
6. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
5. Trucking costs are \$40 per hour to Bee Canyon.
6. Tipping fee at the landfill is assumed to be \$50 per truck.



CONSTRUCTION COST ESTIMATE
Item 5c - Remove Exotic Vegetation and Replace with Native
Recontour Side Slopes to Enlarge Intertidal Habitat Areas
Along Western and Northern Arms, East Shore
and Adjacent to Culvert at Southeast Shore

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$75,000.00	\$75,000
2	Clear and Grub	12,978	SY	\$0.75	\$9,733
3	Dispose of Refuse	1,947	TON	\$75.00	\$146,000
4	Excavation and Grading	9,857	CY	\$12.00	\$118,284
5	Install Upland Vegetation	2	AC	\$6,800.00	\$13,600
4	Install Irrigation	2	AC	\$2,475.00	\$4,950
5	Install Wetland Vegetation	7.1	AC	\$7,290.00	\$51,759
6	Install Irrigation	7.1	AC	\$2,475.00	\$17,573
Subtotal Items					\$436,899
Contingency (25%)					\$109,225
Engineering, Design, Supervision, and Administration (15%)					\$65,535
Environmental Review (5%)					\$21,845
Permitting (5%)					\$21,845
TOTAL					\$655,348

ASSUMPTIONS

1. Mobilization is for an excavator, bulldozer, grader, loader and trucks.
2. Surplus soil material is reused on-site to construct either the island or berms.
3. The construction period is three months.
4. Disposal of vegetative refuse occurs at a conventional landfill.
5. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
6. Trucking costs are \$40 per hour to Bee Canyon.

CONSTRUCTION COST ESTIMATE
Item 6 - Regrade West Shore of West Arm to Improve
Sandy Intertidal Habitat



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$50,000.00	\$50,000
2	Dewater Excavation Area	1	LS.	\$20,000.00	\$20,000
3	Excavate and Regrade	855	CY	\$6.00	\$5,130
Subtotal Items					\$75,130
Contingency (25%)					\$18,783
Engineering, Design, Supervision, and Administration (15%)					\$11,270
Environmental Review (5%)					\$3,757
Permitting (5%)					\$3,757
TOTAL					\$112,695

ASSUMPTIONS

1. The lagoon level is lowered, and the excavation area dewatered and excavated in the dry using earthmoving equipment.
2. Mobilization is for an excavator, bulldozer, grader, loader and trucks.
3. The construction period is one month.



CONSTRUCTION COST ESTIMATE
Item 7a - Install Vegetated Swale and Buffer Along Fenceline
Between Golf Course and Lagoon at Northern Edge

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$50,000.00	\$50,000
2	Clear and Grub	762	SY	\$0.75	\$572
3	Dispose of Refuse	85	TON	\$75.00	\$6,350
4	Excavation and Grading	56	CY	\$6.00	\$339
5	Install Brackish Marsh Vegetation	0.4	AC	\$7,200.00	\$2,880
6	Install Irrigation	0.4	AC	\$2,400.00	\$960
Subtotal Items					\$61,100
Contingency (25%)					\$15,275
Engineering, Design, Supervision, and Administration (15%)					\$9,165
Environmental Review (5%)					\$3,055
Permitting (5%)					\$3,055
TOTAL					\$91,650

ASSUMPTIONS

1. Mobilization is for an excavator, bulldozer, grader, loader and trucks.
2. Surplus soil material is reused on-site to construct either the island or berms.
3. The construction period is one month.
4. Disposal of vegetative refuse occurs at a conventional landfill.
5. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
6. Trucking costs are \$40 per hour to Bee Canyon.

CONSTRUCTION COST ESTIMATE
Item 7b - Move Fenceline Between Lagoon and Golf Course
Back by 10 Feet and Install Vegetated Swale and
Buffer Habitat



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$75,000.00	\$75,000
2	Remove and Reinstall Fence	2,800	LF	\$18.00	\$50,400
3	Clear and Grub	762	SY	\$0.75	\$572
4	Dispose of Refuse	85	TON	\$75.00	\$6,350
5	Excavation and Grading	56	CY	\$6.00	\$339
6	Install Brackish Marsh Vegetation	0.4	AC	\$7,200.00	\$2,880
7	Install Irrigation	0.4	AC	\$2,400.00	\$960
Subtotal Items					\$136,500
Contingency (25%)					\$34,125
Engineering, Design, Supervision, and Administration (15%)					\$20,475
Environmental Review (5%)					\$6,825
Permitting (5%)					\$6,825
TOTAL					\$204,750

ASSUMPTIONS

1. Mobilization is for an excavator, bulldozer, grader, loader and trucks.
2. Surplus soil material is reused on-site to construct either the island or berms.
3. The construction period is two months.
4. Disposal of vegetative refuse occurs at a conventional landfill.
5. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
6. Trucking costs are \$40 per hour to Bee Canyon.



CONSTRUCTION COST ESTIMATE

Item 7c - Move Fenceline Between Lagoon and Golf Course, Narrow and Move Parking Lot and Access Road and Install Vegetated Swale and Buffer Habitat, and Sandy Beach Intertidal Habitat With Berm

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$100,000.00	\$100,000
2	Remove and Reinstall Fence	2,800	LF	\$18.00	\$50,400
3	Demolish Parking Lot and Access Road Including Curb/Gutter	6,400	SY	\$4.00	\$25,600
4	Aggregate Base	1,332	SY	\$4.00	\$5,328
5	Permeable Pavement	1,332	SY	\$9.00	\$11,988
6	Clear and Grub	762	SY	\$0.75	\$572
7	Dispose of Refuse	85	TON	\$75.00	\$6,350
8	Excavation and Grading	2,809	CY	\$12.00	\$33,711
9	Install Brackish Marsh Vegetation	0.4	AC	\$7,200.00	\$2,880
10	Install Irrigation	0.4	AC	\$2,400.00	\$960
Subtotal Items					\$237,789
Contingency (25%)					\$59,447
Engineering, Design, Supervision, and Administration (15%)					\$35,668
Environmental Review (5%)					\$11,889
Permitting (5%)					\$11,889
TOTAL					\$356,683

ASSUMPTIONS

1. Mobilization is for an excavator, a backhoe, asphalt recycler, bulldozer, grader, loader and trucks.
2. Surplus soil material is reused on-site to construct either the island or berms.
3. The construction period is three months.
4. Disposal of vegetative refuse occurs at a conventional landfill.
5. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
6. Trucking costs are \$40 per hour to Bee Canyon.



CONSTRUCTION COST ESTIMATE

**Item 7c/d - Move Fenceline Between Lagoon and Golf Course,
Narrow and Move Parking Lot and Access Road
and Install Vegetated Swale and Buffer Habitat, and
Sandy Beach Intertidal Habitat With Berm, Western Arm Island**

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$100,000.00	\$100,000
2	Remove and Reinstall Fence	2,800	LF	\$18.00	\$50,400
3	Demolish Parking Lot and Access Road Including Curb/Gutter	6,400	SY	\$4.00	\$25,600
4	Aggregate Base	1,332	SY	\$4.00	\$5,328
5	Permeable Pavement	1,332	SY	\$9.00	\$11,988
6	Clear and Grub	762	SY	\$0.75	\$572
7	Dispose of Refuse	85	TON	\$75.00	\$6,350
8	Dewater Excavation Area	1	LS.	\$30,000.00	\$30,000
9	Filling and Grading at Island	10,000	CY	\$12.00	\$120,000
10	Install Brackish Marsh Vegetation	0.4	AC	\$7,200.00	\$2,880
11	Excavation and Grading	2,803	CY	\$12.00	\$33,636
11	Install Irrigation	0.4	AC	\$2,400.00	\$960
Subtotal Items					\$387,714
Contingency (25%)					\$96,928
Engineering, Design, Supervision, and Administration (15%)					\$58,157
Environmental Review (5%)					\$19,386
Permitting (5%)					\$19,386
TOTAL					\$581,571

ASSUMPTIONS

1. Mobilization is for an excavator, a backhoe, asphalt recycler, bulldozer, grader, loader and trucks.
2. Island constructed using material from all other excavated areas of the lagoon perimeter and sand from west shore.
3. The construction period is four months.
4. Disposal of vegetative refuse occurs at a conventional landfill.
5. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
6. Trucking costs are \$40 per hour to Bee Canyon.
7. The lagoon level is lowered, and the excavation area dewatered and excavated in the dry using earthmoving equipment.

CONSTRUCTION COST ESTIMATE
Item 8 - Install Eelgrass



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mob/Demob	1	LS	\$2,500.00	\$2,500
1	Planting	3,000	SF	\$13.00	\$39,000
Subtotal Items					\$41,500
Contingency (25%)					\$10,375
Engineering, Design, Supervision, and Administration (15%)					\$6,225
Environmental Review (5%)					\$2,075
Permitting (5%)					\$2,075
TOTAL					\$62,250

ASSUMPTIONS

CONSTRUCTION COST ESTIMATE
Item 9 - Install Flood Protection Berm



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$20,000.00	\$20,000
2	Excavate and Regrade	200	CY	\$12.00	\$2,400
Subtotal Items					\$22,400
Contingency (25%)					\$5,600
Engineering, Design, Supervision, and Administration (15%)					\$3,360
Environmental Review (5%)					\$1,120
Permitting (5%)					\$1,120
TOTAL					\$33,600

ASSUMPTIONS

CONSTRUCTION COST ESTIMATE
Item 10 - Install Sediment Trap at Western Arm



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$50,000.00	\$50,000
2	Dewater Construction Area	1	LS.	\$30,000.00	\$30,000
3	Excavate Pit	8,300	CY	\$6.00	\$49,800
4	Dispose of Material	8,300	CY	\$15.00	\$124,500
Subtotal Items					\$254,300
Contingency (25%)					\$63,575
Engineering, Design, Supervision, and Administration (15%)					\$38,145
Environmental Review (5%)					\$12,715
Permitting (5%)					\$12,715
TOTAL					\$381,450

ASSUMPTIONS

1. The construction area is dewatered, and excavated and worked in the dry using earthmoving equipment.
2. Mobilization is for an excavator, bulldozer, grader, loader, trucks and concrete mixer.
3. The retention structure is concrete poured in-place.
4. The construction period is two months.

CONSTRUCTION COST ESTIMATE
Item 11 - Install Bioswale at Drain Outlets



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$35,000.00	\$35,000
2	Clear and Grub	95	SY	\$0.75	\$71
3	Dispose of Refuse	385	TON	\$75.00	\$28,856
4	Demolish Drain Outlets	100	LF	\$10.00	\$1,000
5	Excavation and Grading	257	CY	\$12.00	\$3,078
6	Install Brackish Marsh Vegetation	0.1	AC	\$7,200.00	\$720
7	Install Irrigation	0.1	AC	\$2,400.00	\$240
Subtotal Items					\$68,966
Contingency (25%)					\$17,241
Engineering, Design, Supervision, and Administration (15%)					\$10,345
Environmental Review (5%)					\$3,448
Permitting (5%)					\$3,448
TOTAL					\$103,448

ASSUMPTIONS

1. Mobilization is for an backhoe, excavator, bulldozer, grader, loader and trucks.
2. Surplus soil material is reused on-site to construct either the island or berms.
3. The construction period is one month.
4. Disposal of vegetative refuse occurs at a conventional landfill.
5. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
6. Trucking costs are \$40 per hour to Bee Canyon.

CONSTRUCTION COST ESTIMATE
Item 12 - Install Low Flow Diversion to the Sanitary Sewer



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$50,000.00	\$50,000
2	Dewater Construction Area	1	LS.	\$20,000.00	\$20,000
3	Diversion Structure for 48 and 54-inch lines	2	EA	\$20,000.00	\$40,000
4	Diversion Structure for 90-inch line	1	EA	\$27,000.00	\$27,000
5	Pump Station	2	EA	\$100,000.00	\$200,000
6	Wet Well	250	CY	\$600.00	\$150,000
7	Diversion Line	2,400	LF	\$80.00	\$192,000
8	Excavation and Shoring	1,000	CY	\$60.00	\$60,000
9	Shoring Rental	30	WK	\$2,500.00	\$75,000
10	Backfill	800	CY	\$37.50	\$30,000
11	Trash Separation Device (11 cfs)	1	EA	\$95,000.00	\$95,000
12	Trash Separation Devices (62 cfs)	3	EA	\$327,500.00	\$982,500
13	AbTech Catch Basin Filters (Smart Sponges)	24	EA	\$450.00	\$10,800
14	Landscaping	1	LS.	\$55,000.00	\$55,000
Subtotal Items					\$1,987,300
Contingency (25%)					\$496,825
Engineering, Design, Supervision, and Administration (15%)					\$298,095
Environmental Review (5%)					\$99,365
Permitting (5%)					\$99,365
TOTAL					\$2,980,950

ASSUMPTIONS

1. The construction area is dewatered, and excavated and worked in the dry using earthmoving equipment.
2. Mobilization is for an excavator, bulldozer, crane, loader, trucks and concrete mixer.
3. The diversion structure is concrete poured in-place.
4. The construction period is two months.
5. Costs for items 11 and 12 based on use of CDS units.
6. Costs for items 3, 4, 11 and 12 include installation.

CONSTRUCTION COST ESTIMATE
Item 13 - Eliminate Golf Course 7th Hole Long Tee



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	No Construction Proposed	Not Applic	Not Appli	Not Applicable	Not Applicable
	Subtotal Items				\$0
	Contingency (25%)				\$0
	Engineering, Design, Supervision, and Administration (15%)				\$0
	Environmental Review (5%)				\$0
	Permitting (5%)				\$0
	TOTAL				\$0

ASSUMPTIONS

CONSTRUCTION COST ESTIMATE
Item 14a - Install Perimeter Trail with Interpretive Kiosks



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$50,000.00	\$50,000
2	Clear and Grub	4,444	SY	\$0.75	\$3,333
3	Dispose of Refuse	667	TON	\$75.00	\$50,000
4	Excavation and Grading	444	CY	\$6.00	\$2,667
5	Install Trail	6,000	LF	\$1.00	\$6,000
6	Install Kiosks	2	EA	\$15,000.00	\$30,000
7	Install New Furnishings	1	LS.	\$25,000.00	\$25,000
8	Install Interpretive Signs	1	EA	\$10,000.00	\$10,000
Subtotal Items					\$177,000
Contingency (25%)					\$44,250
Engineering, Design, Supervision, and Administration (15%)					\$26,550
Environmental Review (5%)					\$8,850
Permitting (5%)					\$8,850
TOTAL					\$265,500

ASSUMPTIONS

1. The construction period is one month.
2. Mobilization is for a bulldozer, loader and trucks.
3. Disposal of vegetative refuse occurs at a conventional landfill.
4. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
5. Trucking costs are \$40 per hour to Bee Canyon.
6. Tipping fee at the landfill is assumed to be \$50 per truck.
7. Trail is constructed of decomposed granite.

CONSTRUCTION COST ESTIMATE

Item 14b - Install Viewing Platforms, Overlooks and Telescopes



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$50,000.00	\$50,000
2	Clear and Grub	2,222	SY	\$0.75	\$1,667
3	Dispose of Refuse	333	TON	\$75.00	\$25,000
4	Excavation and Grading	222	CY	\$6.00	\$1,333
5	Install Viewing Platforms	2	EA	\$15,000.00	\$30,000
6	Install Overlooks	2	EA	\$5,000.00	\$10,000
7	Install Telescopes	2	EA	\$2,000.00	\$4,000
8	Install New Furnishings	1	LS.	\$25,000.00	\$25,000
9	Install New Small Signs	2	EA	\$2,500.00	\$5,000
10	Install Trail	3,300	LF	\$1.00	\$3,300
11	Install New Pile-Supported Wood Floating Dock Overlook	1,500	SF	\$75.00	\$112,500
12	Install Interpretive Kiosks With Panels	3	EA	\$10,000.00	\$30,000
Subtotal Items					\$297,800
Contingency (25%)					\$74,450
Engineering, Design, Supervision, and Administration (15%)					\$44,670
Environmental Review (5%)					\$14,890
Permitting (5%)					\$14,890
TOTAL					\$446,700

ASSUMPTIONS

1. The construction period is two months.
2. Mobilization is for a bulldozer, loader and trucks.
3. Disposal of vegetative refuse occurs at a conventional landfill.
4. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
5. Trucking costs are \$40 per hour to Bee Canyon.
6. Tipping fee at the landfill is assumed to be \$50 per truck.
7. Platforms are constructed of wood.
8. Overlooks are graded knolls.

CONSTRUCTION COST ESTIMATE
Item 15 - Improve Trash Management Protocols



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	City Staff Time	200	HRS	\$50.00	\$10,000
2	Administrative Resources (copying, processing, etc.)	1	LS.	\$2,500.00	\$2,500
3	Additional Receptacles	10	EA	\$500.00	\$5,000
Subtotal Items					\$17,500
Contingency (25%)					\$4,375
Engineering/Technical Support (15%)					\$2,625
Environmental Review (5%)					\$875
Permitting (5%)					\$875
TOTAL					\$26,250

ASSUMPTIONS

1. Implementation requires City staff time, resources and additional receptacles.

CONSTRUCTION COST ESTIMATE
Item 16 - Implement Bird Management Protocols



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	City Staff Time	100	HRS	\$100.00	\$10,000
2	Administrative Resources (Leaflets, copying, processing, etc.)	1	LS.	\$2,500.00	\$2,500
3	Signage	8	EA	\$500.00	\$4,000
Subtotal Items					\$16,500
Contingency (25%)					\$4,125
TOTAL					\$20,625

ASSUMPTIONS

1. Implementation requires City staff time, resources and signage.

CONSTRUCTION COST ESTIMATE
Item 17a - Continue Existing Sand Nourishment Practices



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$10,000.00	\$10,000
2	Deliver Sand	100	CY	\$5.00	\$500
3	Regrade Beach	100	CY	\$2.50	\$250
Subtotal Items					\$10,750
Contingency (25%)					\$2,688
Engineering, Design, Supervision, and Administration (15%)					\$1,613
Environmental Review (5%)					\$538
Permitting (5%)					\$538
TOTAL					\$16,125

ASSUMPTIONS

1. The sand is trucked to the site and placed consistent with existing practices
2. Mobilization is for a bulldozer, loader and trucks.
3. The construction period is two weeks.

CONSTRUCTION COST ESTIMATE
Item 17b - Modify Sand Nourishment Practices



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$10,000.00	\$10,000
2	Deliver Sand	50	CY	\$7.50	\$375
3	Regrade Beach	50	CY	\$2.50	\$125
Subtotal Items					\$10,500
Contingency (25%)					\$2,625
Engineering, Design, Supervision, and Administration (15%)					\$1,575
Environmental Review (5%)					\$525
Permitting (5%)					\$525
TOTAL					\$15,750

ASSUMPTIONS

1. The sand is trucked to the site and placed differently than existing City practices.
2. Mobilization is for a bulldozer, loader and trucks.
3. The construction period is two weeks.

CONSTRUCTION COST ESTIMATE
Item 17c - Discontinue Sand Nourishment



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
	No Construction Proposed	Not Applic	Not Applic	Not Applicable	Not Applicable
	Subtotal Items				\$0
	Contingency (25%)				\$0
	Engineering, Design, Supervision, and Administration (15%)				\$0
	Environmental Review (5%)				\$0
	Permitting (5%)				\$0
	TOTAL				\$0

ASSUMPTIONS

CONSTRUCTION COST ESTIMATE
Item 18 - Install Watershed Impacts Education Display



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	City Staff Time	80	HRS	\$100.00	\$8,000
2	Administrative Resources (Leaflets, copying, processing, etc.)	1	LS.	\$2,500.00	\$2,500
3	Interpretive Displays	4	EA	\$10,000.00	\$40,000
Subtotal Items					\$50,500
Contingency (25%)					\$12,625
TOTAL					\$63,125

ASSUMPTIONS

1. Implementation requires City staff time, resources and installation of interpretive displays.

CONSTRUCTION COST ESTIMATE
Item 1a - Clean Culvert



ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	1	LS.	\$35,000.00	\$35,000
2	Rock Removal	75	TON	\$25.00	\$1,875
3	Fabricate Dozer Blade for Cleaning	1	EA	\$5,000.00	\$5,000
4	Debris and Biofoul Removal	905	TON	\$6.00	\$5,430
5	Clear Trash Rack	1	TON	\$500.00	\$500
6	Haul Waste Material to Landfill	905	TON	\$75.00	\$67,875
Subtotal Items					\$115,680
Contingency (25%)					\$28,920
Engineering, Design, Supervision, and Administration (15%)					\$17,352
Environmental Review (5%)					\$5,784
Permitting (5%)					\$5,784
TOTAL					\$173,520

ASSUMPTIONS

1. The culvert is drained, dewatered and cleaned in the dry using a small bulldozer outfitted with special equipment.
2. The material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 1 hour round-trip to a conventional landfill.
3. It is assumed for this estimate that the material cleared from the culvert is not contaminated. Confirmation of this assumption should be made through investigations of the material.
4. Trucking costs are \$40 per hour.
5. Tipping fees are \$50 per ton.
6. The construction period is two weeks.
7. Mobilization includes a bulldozer, crane and backhoe.

Appendix D
Updated Cost Estimate Spreadsheets
- Maintenance Estimates

LONG-TERM MANAGEMENT AND MONITORING
Item 1b - Build Open Channel
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	0.1	1	LS.	\$50,000.00	\$5,000
2	Repair Revetment	0.1	500	TON	\$30.00	\$1,500
3	Bridge Maintenance	0.1	5,640	SF	\$7.50	\$4,230
4	Fence Maintenance	0.2	2100	LF	\$5.00	\$2,100
5	Sign Maintenance	0.2	500	EA	\$10.00	\$1,000
6	Trash Removal	4	1	TON	\$100.00	\$400
7	Haul Trash Material to a Conventional Landfill	4	1	TON	\$75.00	\$300
Subtotal Items						\$14,530
Contingency (25%)						\$3,633
Engineering/Technical Support (15%)						\$2,180
TOTAL						\$20,342

ASSUMPTIONS

1. Trash and other refuse is hauled to a conventional landfill and trucking costs are \$40 per hour.
2. Tipping fees of \$50 per ton are required.
3. The maintenance period is two weeks.
4. Mobilization includes a crane and trucks.

LONG-TERM MANAGEMENT AND MONITORING
Item 1c - Use Existing Channel and Build Open Channel
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	0.1	1	LS.	\$50,000.00	\$5,000
2	Repair Revetment	0.1	500	TON	\$30.00	\$1,500
3	Bridge Maintenance	0.1	5,640	SF	\$7.50	\$4,230
4	Fence Maintenance	0.2	2100	LF	\$5.00	\$2,100
5	Sign Maintenance	0.2	500	EA	\$10.00	\$1,000
6	Maintain and Repair Tide Gates (One Time Every Five Years)	0.2	2	EA	\$10,000.00	\$4,000
7	Debris and Biofoul Removal (One Time Every Ten Years)	0.1	226	CY	\$6.00	\$136
8	Clear Trash Rack and Remove from Channel (Four Times Per Year)	4	2	TON	\$500.00	\$4,000
9	Haul Debris and Biofoul Material to Landfill (Once/Ten Years)	0.1	113	TON	\$75.00	\$848
	Subtotal Items					\$22,814
	Contingency (25%)					\$5,704
	Engineering/Technical Support (15%)					\$3,422
	TOTAL					\$31,940

ASSUMPTIONS

1. Trash and other refuse is hauled to a conventional landfill and trucking costs are \$40 per hour.
2. Tipping fees of \$50 per ton are required.
3. The maintenance period is two weeks.
4. Mobilization includes a crane, bulldozer and trucks.
5. The material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 1 hour round-trip to a conventional landfill.
6. It is assumed for this estimate that the material cleared from the culvert is not contaminated. Confirmation of this assumption should be made through investigations of the material.

LONG-TERM MANAGEMENT AND MONITORING
Item 2 - Remove Contaminated Sediment in the Western Arm
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
	No Maintenance Proposed	Not Applicable	Not Applicable		Not Applicable	Not Applicable
	Subtotal Items					\$0
	Contingency (25%)					\$0
	Engineering, Design, Supervision, and Administration (15%)					\$0
	Environmental Review (5%)					\$0
	Permitting (5%)					\$0
	TOTAL					\$0

ASSUMPTIONS

LONG-TERM MANAGEMENT AND MONITORING
Item 3 - Remove Compromised Sediment in the Central Lagoon
ANNUAL COSTS



AREA 2 COMBINED RE-USE ON-SITE AND HAULED TO THE PORT OF LONG BEACH

ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
	No Maintenance Proposed	Not Applicable	Not Applicable		Not Applicable	Not Applicable
	Subtotal Items					\$0
	Contingency (25%)					\$0
	Engineering, Design, Supervision, and Administration (15%)					\$0
	Environmental Review (5%)					\$0
	Permitting (5%)					\$0
	TOTAL					\$0

ASSUMPTIONS

LONG-TERM MANAGEMENT AND MONITORING
Item 4 - Implement Watershed BMPs
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Construction Activities	1	1	LS	\$1,000.00	\$1,000.00
2	Street Sweeping	1	1	LS	\$6,000.00	\$6,000.00
3	Commercial Area Wash Down	1	1	LS	\$1,400.00	\$1,400.00
4	Over Watering	1	1	LS	\$3,000.00	\$3,000.00
5	Golf Course Herbicide/Pesticide Use	1	1	LS	\$2,000.00	\$2,000.00
Subtotal Items						\$13,400
Contingency (25%)						\$3,350
Engineering, Design, Supervision, and Administration (5%)						\$670
TOTAL						\$17,420

ASSUMPTIONS

1. Costs provided by HDR/CGVL, and modified assuming 10% of the cost of items are assigned to the lagoon project.

LONG-TERM MANAGEMENT AND MONITORING
Item 5a - Remove Exotic Vegetation and Replace with Native
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Vegetation Maintenance	1	2.6	AC	\$2,464.00	\$6,516
2	Trash Removal	4	0.5	TON	\$100.00	\$200
Subtotal Items						\$6,716
Contingency (25%)						\$1,679
TOTAL						\$8,395

ASSUMPTIONS

1. The maintenance period is three days.
2. Disposal of vegetative refuse occurs at a conventional landfill.

LONG-TERM MANAGEMENT AND MONITORING
Item 5b - Remove Exotic Vegetation and Replace with Native
Recontour Side Slopes to Enlarge Intertidal Habitat Areas
Along Western and Northern Arms and East Shore



ANNUAL COSTS

ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Vegetation Maintenance	1	2.6	AC	\$2,464.00	\$6,516
2	Trash Removal	4	1	TON	\$100.00	\$400
Subtotal Items						\$6,916
Contingency (25%)						\$1,729
TOTAL						\$8,645

ASSUMPTIONS

1. The maintenance period is four days.
2. Disposal of vegetative refuse occurs at a conventional landfill.

LONG-TERM MANAGEMENT AND MONITORING
Item 5c - Remove Exotic Vegetation and Replace with Native
Recontour Side Slopes to Enlarge Intertidal Habitat Areas
Along Western and Northern Arms, East Shore
and Adjacent to Culvert at Southeast Shore



ANNUAL COSTS

ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Vegetation Maintenance	1	2.7	AC	\$2,464.00	\$6,607
2	Trash Removal	4	1.5	TON	\$100.00	\$600
Subtotal Items						\$7,207
Contingency (25%)						\$1,802
TOTAL						\$9,009

ASSUMPTIONS

1. The maintenance period is five days.
2. Disposal of vegetative refuse occurs at a conventional landfill.

LONG-TERM MANAGEMENT AND MONITORING
Item 6 - Regrade West Shore of West Arm to Improve
Sandy Intertidal Habitat
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
	No Maintenance Proposed	Not Applicable	Not Applic	Not Applic	Not Applicable	Not Applicable
	Subtotal Items					\$0
	Contingency (25%)					\$0
	Engineering, Design, Supervision, and Administration (15%)					\$0
	Environmental Review (5%)					\$0
	Permitting (5%)					\$0
	TOTAL					\$0

ASSUMPTIONS

LONG-TERM MANAGEMENT AND MONITORING
Item 7a - Install Vegetated Swale and Buffer Along Fenceline
Between Golf Course and Lagoon at Northern Edge
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Vegetation Maintenance	1	0.2	AC	\$2,464.00	\$388
2	Trash Removal	4	0.5	TON	\$100.00	\$200
Subtotal Items						\$588
Contingency (25%)						\$147
TOTAL						\$735

ASSUMPTIONS

1. The maintenance period is one day.
2. Item 1 includes disposal at a conventional landfill.

LONG-TERM MANAGEMENT AND MONITORING
Item 7b - Move Fenceline Between Lagoon and Golf Course
Back by 10 Feet and Install Vegetated Swale and
Buffer Habitat



ANNUAL COSTS

ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Vegetation Maintenance	1	0.2	AC	\$2,464.00	\$388
2	Trash Removal	4	0.5	TON	\$100.00	\$200
3	Fence Maintenance	0.2	2800	LF	\$5.00	\$2,800
Subtotal Items						\$3,388
Contingency (25%)						\$847
TOTAL						\$4,235

ASSUMPTIONS

1. The maintenance period is five days.
2. Items 1 and 2 include disposal at a conventional landfill.
3. The cost of disposal is \$100 per ton.
4. Disposal of vegetative refuse occurs at a conventional landfill.
5. Refuse material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hours round-trip.
6. Trucking costs are \$40 per hour to Bee Canyon.

LONG-TERM MANAGEMENT AND MONITORING
Item 7c - Move Fenceline Between Lagoon and Golf Course,
Narrow and Move Parking Lot and Access Road
and Install Vegetated Swale and Buffer Habitat, and
Sandy Beach Intertidal Habitat With Berm



ANNUAL COSTS

ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization/Demobilization	0.5	1	SF	\$5,000.00	\$2,500
1	Vegetation Maintenance	1	0.2	AC	\$2,464.00	\$388
2	Fence Maintenance	0.2	2800	LF	\$5.00	\$2,800
3	Permeable Pavement Maintenance	0.2	57750	SF	\$0.10	\$1,155
4	Berm Maintenance	0.5	450	LF	\$1.00	\$225
5	Trash Removal	4	1	TON	\$100.00	\$400
Subtotal Items						\$7,468
Contingency (25%)						\$1,867
Engineering/Technical Support (15%)						\$1,120
TOTAL						\$10,455

ASSUMPTIONS

1. Mobilization is for a bulldozer.
2. The maintenance period is two weeks.
3. Items include disposal at a conventional landfill.

LONG-TERM MANAGEMENT AND MONITORING
Item 7c/d - Move Fenceline Between Lagoon and Golf Course,
Narrow and Move Parking Lot and Access Road
and Install Vegetated Swale and Buffer Habitat, and
Sandy Beach Intertidal Habitat With Berm, Western Arm Island



ANNUAL COSTS

ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization/Demobilization	0.5	1	SF	\$5,000.00	\$2,500
1	Vegetation Maintenance	1	0.2	AC	\$2,464.00	\$388
2	Fence Maintenance	0.2	2800	LF	\$5.00	\$2,800
3	Permeable Pavement Maintenance	0.2	57750	SF	\$0.10	\$1,155
4	Island Maintenance	0.5	3500	SF	\$1.00	\$1,750
5	Berm Maintenance	0.5	450	LF	\$1.00	\$225
6	Trash Removal	4	1	TON	\$100.00	\$400
Subtotal Items						\$9,218
Contingency (25%)						\$2,304
Engineering/Technical Support (15%)						\$1,383
TOTAL						\$12,905

ASSUMPTIONS

1. Mobilization is for a bulldozer.
2. The maintenance period is two weeks.
3. Items include disposal at a conventional landfill.

LONG-TERM MANAGEMENT AND MONITORING
Item 8 - Install Eelgrass
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
	No Maintenance Proposed	Not Applicable	Not Applic	Not Appli	Not Applicable	Not Applicable
	Subtotal Items					\$0
	Contingency (25%)					\$0
	Engineering, Design, Supervision, and Administration (15%)					\$0
	Environmental Review (5%)					\$0
	Permitting (5%)					\$0
	TOTAL					\$0

ASSUMPTIONS

LONG-TERM MANAGEMENT AND MONITORING
Item 9 - Install Flood Protection Berm
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization/Demobilization	0.5	1	SF	\$5,000.00	\$2,500
1	Berm Maintenance	0.5	350	LF	\$1.00	\$175
	Subtotal Items					\$2,675
	Contingency (25%)					\$669
	Engineering, Design, Supervision, and Administration (15%)					\$401
	Environmental Review (5%)					\$134
	Permitting (5%)					\$134
	TOTAL					\$4,013

ASSUMPTIONS

1. Mobilization includes a bulldozer and truck.

LONG-TERM MANAGEMENT AND MONITORING
Item 10 - Install Sediment Trap at Western Arm
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	0.05	1	LS.	\$25,000.00	\$1,250
2	Dewater Maintenance Area	0.05	1	LS.	\$20,000.00	\$1,000
3	Excavate Sediment	0.05	1000	CY	\$6.00	\$300
4	Sediment Disposal	0.05	1000	CY	\$15.00	\$750
Subtotal Items						\$3,300
Contingency (25%)						\$825
Engineering, Design, Supervision, and Administration (15%)						\$495
Environmental Review (5%)						\$165
Permitting (5%)						\$165
TOTAL						\$4,950

ASSUMPTIONS

1. The construction area is dewatered, and excavated and worked in the dry using earthmoving equipment.
2. Mobilization is for an excavator, loader, and trucks.
3. The construction period is two weeks.

LONG-TERM MANAGEMENT AND MONITORING
Item 11 - Install Bioswale at Drain Outlets
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Vegetation Maintenance	1	0.02	AC	\$2,464.00	\$48
2	Trash Removal	4	0.25	TON	\$100.00	\$100
Subtotal Items						\$148
Contingency (25%)						\$37
TOTAL						\$185

ASSUMPTIONS

1. The maintenance period is five days.
2. Items include disposal at a conventional landfill.

LONG-TERM MANAGEMENT AND MONITORING
Item 12 - Install Low Flow Diversion to the Sanitary Sewer
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Monthly Wet Well Inspection for Debris	12	16	HRS	\$50.00	\$9,600
2	Clean-Out of Trash Separation Devices	4	4	EA	\$2,000.00	\$32,000
3	Remove Debris	12	0.01	TON	\$100.00	\$12
Subtotal Items						\$41,612
Contingency (25%)						\$10,403
TOTAL						\$52,015

ASSUMPTIONS

1. The maintenance period is one day per month for the wet wells.
2. The maintenance period is one day per quarter for the trash separation devices.

LONG-TERM MANAGEMENT AND MONITORING
Item 13 - Eliminate Golf Course 7th Hole Long Tee
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
	No Maintenance Proposed	Not Applicable	Not Applic	Not Applic	Not Applicable	Not Applicable
	Subtotal Items					\$0
	Contingency (25%)					\$0
	Engineering, Design, Supervision, and Administration (15%)					\$0
	Environmental Review (5%)					\$0
	Permitting (5%)					\$0
	TOTAL					\$0

ASSUMPTIONS

LONG-TERM MANAGEMENT AND MONITORING
Item 14a - Install Perimeter Trail with Interpretive Kiosks
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Maintain Trail	1	6000	LF	\$0.25	\$1,500
2	Maintain Kiosks	1	2	EA	\$2,000.00	\$4,000
3	Maintain Interpretive Signs	1	1	EA	\$1,000.00	\$1,000
Subtotal Items						\$6,500
Contingency (25%)						\$1,625
Engineering/Technical Support (15%)						\$975
TOTAL						\$9,100

ASSUMPTIONS

1. The maintenance period is one week.

LONG-TERM MANAGEMENT AND MONITORING
Item 14b - Install Viewing Platforms, Overlooks and Telescopes
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Maintain Viewing Platforms	1	2	EA	\$2,000.00	\$4,000
2	Maintain Overlooks	1	2	EA	\$1,000.00	\$2,000
3	Maintain Telescopes	1	2	EA	\$500.00	\$1,000
4	Maintain Small Signs	1	3	EA	\$500.00	\$1,500
5	Maintain Trail	1	3300	LF	\$0.25	\$825
6	Maintain Pile-Supported Wood Floating Dock Overlook	1	1	LS	\$2,815.00	\$2,815
7	Maintain Kiosks	1	3	EA	\$2,000.00	\$6,000
Subtotal Items						\$18,140
Contingency (25%)						\$4,535
Engineering/Technical Support (15%)						\$2,721
TOTAL						\$25,396

ASSUMPTIONS

1. The maintenance period is one week.

LONG-TERM MANAGEMENT AND MONITORING
Item 15 - Improve Trash Management Protocols
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	City Staff Time	1	80	HRS	\$50	\$4,000
2	Administrative Resources (copying, processing, etc.)	1	1	LS	\$0	\$0
3	Trash Pick-up and Disposal	4	4	TON	75	\$1,200
Subtotal Items						\$5,200
Contingency (25%)						\$1,300
TOTAL						\$6,500

ASSUMPTIONS

1. Trash disposed of at a conventional dump site with a \$50/ton tipping fee, and \$25 to truck.

LONG-TERM MANAGEMENT AND MONITORING
Item 16 - Implement Bird Management Protocols
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Domestic Bird Removal	2	10	EA	\$10.00	\$200
Subtotal Items						\$200
Contingency (25%)						\$50
TOTAL						\$250

ASSUMPTIONS

LONG-TERM MANAGEMENT AND MONITORING
Item 17a - Continue Existing Sand Nourishment Practices
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	0.5	1	LS.	\$10,000.00	\$5,000
2	Deliver Sand	0.5	100	CY	\$5.00	\$250
3	Regrade Beach	0.5	100	CY	\$2.50	\$125
Subtotal Items						\$5,375
Contingency (25%)						\$1,344
Engineering/Technical Support (15%)						\$806
Permitting (5%)						\$269
TOTAL						\$7,794

ASSUMPTIONS

1. The sand is trucked to the site and placed consistent with existing practices.
2. Mobilization is for a bulldozer, loader and trucks.
3. The maintenance period is one week.

LONG-TERM MANAGEMENT AND MONITORING
Item 17b - Modify Sand Nourishment Practices
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization	0.5	1	LS.	\$10,000.00	\$5,000
2	Deliver Sand	0.5	50	CY	\$7.50	\$188
3	Regrade Beach	0.5	50	CY	\$2.50	\$63
Subtotal Items						\$5,250
Contingency (25%)						\$1,313
Engineering/Technical Support (15%)						\$788
Permitting (5%)						\$263
TOTAL						\$7,613

ASSUMPTIONS

1. The sand is trucked to the site and placed modified from existing practices.
2. Mobilization is for a bulldozer, loader and trucks.
3. The maintenance period is one week.

LONG-TERM MANAGEMENT AND MONITORING
Item 17c - Discontinue Sand Nourishment
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
	Rake Beach	4	67,500	SF	\$0.01	\$2,700
	Subtotal Items					\$2,700
	Contingency (25%)					\$675
	TOTAL					\$3,375

ASSUMPTIONS

LONG-TERM MANAGEMENT AND MONITORING
Item 18 - Install Watershed Impacts Education Display
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Maintain Interpretive Displays	0.2	1	EA	\$10,000.00	\$2,000
	Subtotal Items					\$2,000
	Contingency (25%)					\$500
	TOTAL					\$2,500

ASSUMPTIONS

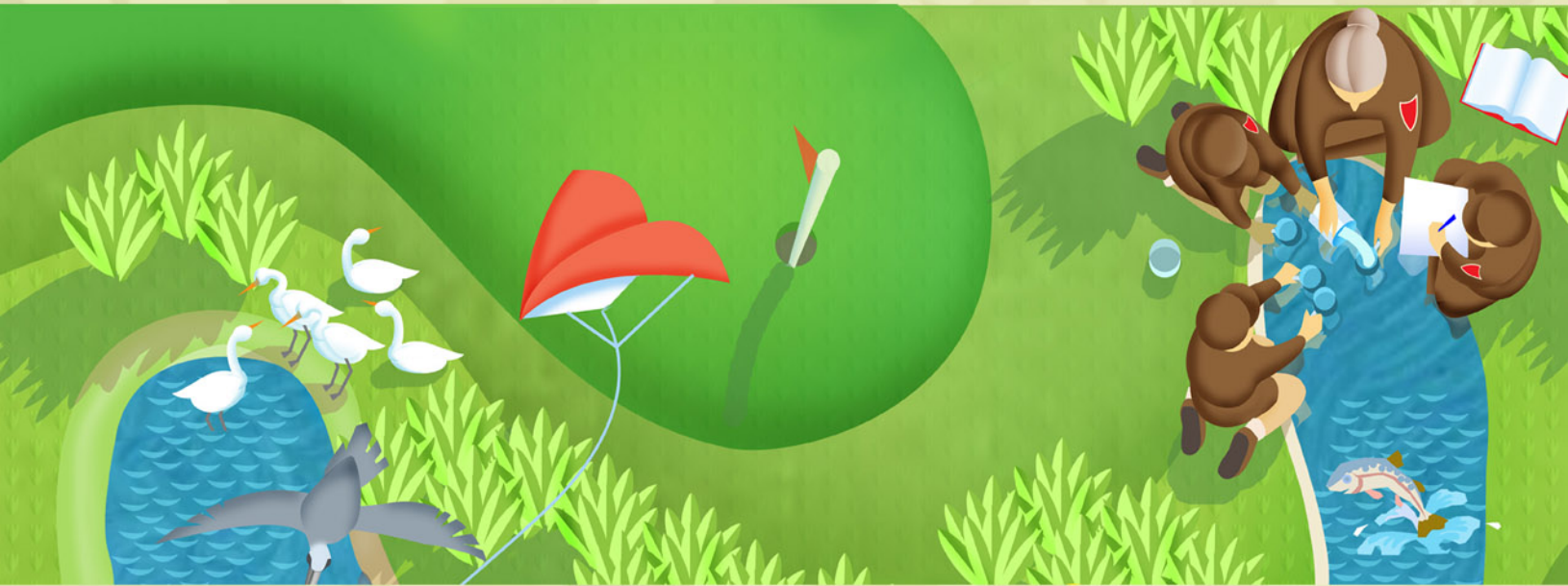
LONG-TERM MANAGEMENT AND MONITORING
Item 1a - Clean Culvert
ANNUAL COSTS



ITEM NO.	ITEM DESCRIPTION	FREQUENCY/YR	QUANTITY	UNIT	UNIT COST	SUBTOTAL
1	Mobilization & Demobilization (One Time Every Ten Years)	0.1	1	LS.	\$35,000.00	\$3,500
2	Maintain and Repair Tide Gates (One Time Every Five Years)	0.2	2	EA	\$10,000.00	\$4,000
3	Debris and Biofoul Removal (One Time Every Ten Years)	0.1	226	CY	\$6.00	\$136
4	Clear Trash Rack (Four Times Per Year)	4	1	TON	\$500.00	\$2,000
5	Haul Debris and Biofoul Material to Landfill (Once/Ten Years)	0.1	113	TON	\$75.00	\$848
6	Haul Trash Material to Landfill (Four Times Per Year)	4	1	TON	\$75.00	\$300
Subtotal Items						\$10,784
Contingency (25%)						\$2,696
Engineering/Technical Support (15%)						\$1,618
TOTAL						\$15,098

ASSUMPTIONS

1. The culvert is drained, dewatered and cleaned in the dry using a small bulldozer outfitted with special equipment.
2. The material is trucked in a rig with a capacity of 8 cubic yards per load for a transport time of 2 hour round-trip to a conventional landfill.
3. It is assumed for this estimate that the material cleared from the culvert is not contaminated. Confirmation of this assumption should be made through investigations of the material.
4. Trucking costs are \$40 per hour.
5. Tipping fees are \$50 per ton.
6. The maintenance period is five days.
7. Mobilization includes one bulldozer and 1 crane to lift the doors and lift the dozer to and from the culvert.



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